JOURNAL

OF THE

FRANKLIN INSTITUTE

OF THE STATE OF PENNSYLVANIA.

FOR THE

PROMOTION OF THE MECHANIC ARTS.

VOL. LXVII.] JANUARY, 1874. No. 1.

EDITORIAL.

ITEMS AND NOVELTIES.

The Centennial Exposition.—The movement in aid of this great national project is making steady progress. The active co-operation of a number of the States has at length been obtained, or pledged, and the outlook for the early undertaking of active operations in its behalf is most favorable.

The plan of the buildings in which the Exposition is to be held has already been decided upon, the successful architect being Mr. Vaux, of New York city. The accompanying plate represents a ground plan of these buildings, which it is proposed to erect at the earliest period, upon the site, in Fairmount Park, donated by the city of Philadelphia to the U. S. Centennial Commission for the purposes of the Exposition.*

This plan gives an idea of the relative position of the several buildings, and, to those familiar with the location, their relation to well-known portions of the Park. The following table of references gives the designation and functions of the several parts of the plan, viz.:

A. The Machinery Hall.

B. The Agricultural Hall.

* We are indebted for the plate to the courtesy of the Editors of the Jour. of the Exposition and Evening Bulletin, Philadelphia.

C. The Conservatory.
E. Centennial Avenue.
F. The Terrace.
H. George's Hill.
M. The Art Gallery.
N. Covered Way between the Buildings.
K. Belmont Reservoir.
P. Main Exposition Building.

The grand pavillion, or main exposition building (marked P), according to present design, will have a length of 2,075 feet, and a width at the centre and ends of 1,000 feet. The length of Agricultural Hall will be 1,420 feet, and of Machinery Hall 2,275 feet.

The area of ground appropriated in the Park for the purposes of the Exposition is 450 acres. Of this space, the Grand Pavillion covers 35½ acres, with the capacity of considerable extension if found necessary, or expedient. The Machinery Hall will cover 9½ acres. and the Agricultural Hall 4½ acres.

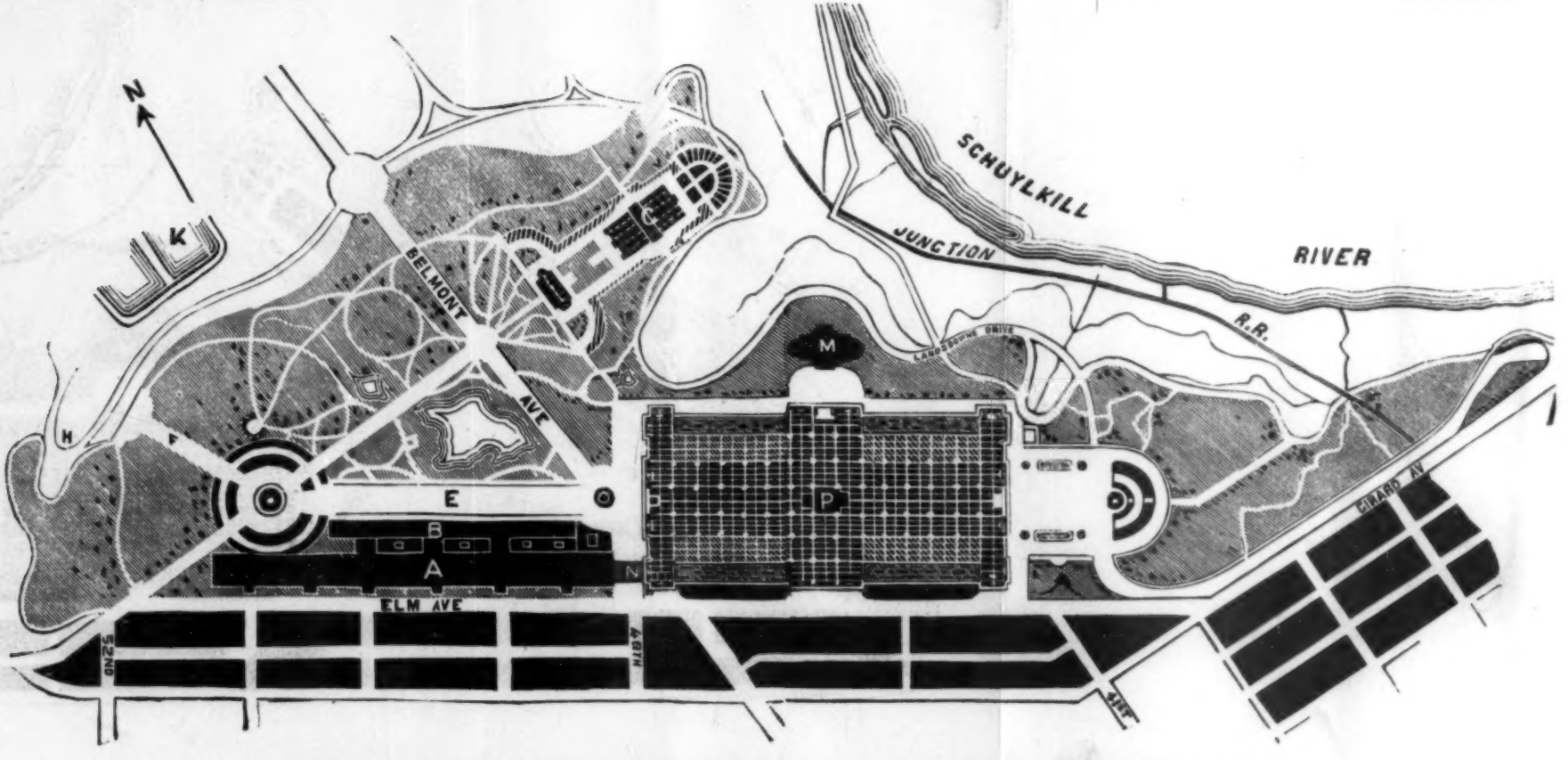
It will be observed that Machinery Hall is to be located directly upon Elm Avenue, within a very short distance of the Pennsylvania Railroad tracks, so that no difficulty will be found in making a siding upon which heavy castings, etc., can be run directly into the Hall.

The following figures represent the areas of former expositions, and will serve as a comparison with that appropriated for the coming event.

The space included for the purposes of the Exposition was, at—

	Sq. Yards.
London (Hyde Park), 1851,	88,934
Paris (Champs Elysées), 1855,	112,450
London (Brompton), 1862,	202,920
Paris (Champs de Mars), 1867,	481,500
Vienna (Prater), 1873,	2,530,400
Philadelphia (Fairmount Park), 1876,	3,070,000

In continuation of the same subject, it may be interesting to add, in conclusion, that Prof. W. P. Blake, of Connecticut, a member of the United States Centennial Commission, has prepared a somewhat voluminous report of his mission to the Vienna Exposition, he having been assigned this duty by the Centennial Executive Committee. He refers with great satisfaction to the general sentiment abroad in reference to the American Centennial Exposition. In reference to what foreigners expect, Prof. Blake says: A very intelligent interest



GROUND PLAN OF BUILDINGS FOR THE CENTENNIAL EXPOSITION, 1876.

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was manifested generally by the exhibitors at Vienna, and there were inquiries for the regulations in detail of our exhibition. It is here my duty to state plainly that, notwithstanding the very favorable disposition shown, not only by Austro-Hungary, but by the German empire, Belgium and other countries, they will not participate with us unless they are fully satisfied with our plans and regulations. The exhibitors are now so habituated to great international exhibitions that they are intelligent critics of their organization and regulations. They have had disagreeable experience in some respects, and they will not subject themselves to like difficulties. They, therefore, look with anxiety to the tenor of our regulations, and it behooves us to exercise extreme caution in regard to them.

I herewith submit some of the points upon which anxiety has been manifested, and suggestions have been made by some of the foreign commissions and exhibitors:

First. Protection of their property and protection of the interests of exhibitors. To this end the organization of a responsible body to act as agent of foreign exhibitors to receive, place, describe, guard and to dispose of or return articles sent, and further to give information concerning them to jurors or others.

Second. A well-devised system of awards, a judicious selection of jurors, and effective organization of the jury.

Third. Facilities for transportation and protection from needless expenses of moving, unpacking, placing and removing goods.

Fourth. Favorable and simple customs regulations.

Fifth. Permission to trade under proper restrictions.

Sixth. Facilities for advertising.

Seventh. Early publication of a good catalogue assured.

Eighth. Provision for descriptive reports and publication of the results of the exhibition.

A Remarkable Experiment in Punching Cold Iron.—At the meeting of the Franklin Institute, held in December, 1873, two cold-punched hexagon nuts were exhibited by Messrs. Hoopes & Townsend, bolt, nut and washer makers, of this city. These specimens are worthy of attention from the fact that one of them had a hole one quarter of an inch in diameter and one inch deep; the other was perforated with a hole half an inch in diameter and one and a half inch deep.

These specimens are remarkable, when we take into consideration

the oft-made statement "that the maximum thickness of iron that can be punched cold is about the diameter of the punch," as the depth of the smaller nut is four diameters of the punch, and that of the larger one three diameters of the punch.

In conversation with Mr. Barton Hoopes, who has conducted these experiments, I learn that he has since succeeded in punching a half-inch hole through inch and three-qnarters thickness of wrought iron; the punching which came out of the hole I have examined, and it differs in no respect from ordinary punchings, but it has been compressed to seven-eighths of an inch in length; that is, the punching shows an irregular cylinder half inch in diameter and seven-eighths inch long: the metal forming the punching is not condensed into a smooth cylinder, but shows the usual roughness common to all punchings, while the punched holes are very smooth. The punch and die-hole are the same size, and there has evidently been a side flow of the cold iron upon the entrance of the punch. The operation may, in a measure, be considered a piercing one up to a certain depth, and finally a punching out of the residuum after it has attained that depth.

In punching the quarter-inch hole through one-inch iron, the punching showed a very smooth surface, and was only three-eighths of an inch long, seemingly very much compressed.

I have examined the punches used in this curious experiment, and find that they differ in no respect from ordinary punches. They are made of good steel, and hardened in some peculiar manner unknown to me.

Bars of iron one inch square, punched with a quarter inch punch, show a sensible widening under the action of the punch, and a bar of inch and three-quarters square iron, punched with a half-inch punch, is swelled sideways to one inch and thirteen-sixteenths, showing conclusively that some of the iron has been forced sideways.

The machines used in driving the punch through this great thickness are said to be of great strength and accuracy of construction.

COLEMAN SELLERS.

South Street Bridge.—The following information from official source may interest our readers:

This structure is approaching completion. The caps that carry the superstructure are now being put in place upon the pneumatic cylinders, and these, when finished, which will be in a few days, will en-

able the work of the erection of the iron superstructure to go on. The iron work is being rapidly executed in the different shops, and it is confidently expected that this beautiful bridge will be ready for crossing early in the spring of 1874.

The superstructure, which will be entirely of wrought iron, will be characterized by several new features. The diagonals, both main and counters, are flat bars, generally 10 inches in width, with a varying thickness proportional to the strain. The object in this is to avoid the frail cobweb appearance of a like structure with diagonals of round or square forms. All the columns or posts are of the Reeves' Patent, the neck at the top chord finished with a delicate Corinthian-leaved capital; the columns and cross girders are braced with strong wrought iron fret arches. Three of these arches spring from each post, the effect of them enclosing, as it will appear from the inside, the rich Corinthian capitals of the post will be that of a long vista, and when lighted at night cannot fail to be beautiful. At all events, Mr. Murphy, the designer and builder, has made a successful attempt at gaining a new style in bridge architecture. When the Fairmount and Girard Avenue bridges are completed, Philadelphia can boast that she has at least four grand bridges, including the Chestnut St., and each bridge in a different style of architecture, and each bridge by a different Philadelphia Civil Engineer.

The Boiler Tests at Sandy Hook.—The U. S. Commission appointed to conduct a series of experimental trials with steam boilers, with the view of determining the truth or fallacy of the numerous theories of steam boiler explosions, commenced its work at Sandy Hook on the 7th of November.

The constitution of the Commission, and an outline of the work it has prepared, have already been published in the Journal.

The boilers experimented upon were two in number: one of them a small, upright, tubular boiler, and the other a large low pressure boiler, such as is in general use on steamers in New York harbor.

The aim of the experiment with the first-named boiler was to test the theory that, with low water in the boiler, the plates may become heated sufficiently to materially diminish their power of resisting strain.

During the experiment, the spectators occupied a bomb-proof casemate, some hundreds of feet from the boiler. The result was the collapsing of a tube at a pressure of 54 pounds. A pyrometer at-

tached to the lower part of the boiler indicated that the steam in the upper part of the boiler was highly superheated at the moment of explosion, and the opinion prevailed that the experiment proved the truth of the theory.

The low pressure boiler was heated to a steam pressure of 70 lbs., at which point it ruptured a seam without doing further damage. The rupture occurred in a soft patch on the upper side of the shell, and was about 18 inches long.

It was shown by the gauges that, even after the rupture occurred, the pressure continued to increase, and the rupture did not extend. It was therefore concluded that overpressure of steam will rupture a boiler with a weak spot, while if it be uniformly strong in all its parts, it will, in all probability, explode violently from this cause—a conclusion simply reiterating that announced by Col. Stephens, from experiments at the same place some two years ago, and then published in the Journal. The experiments were continued at Pittsburg, and have been postponed until the spring.

The Lost Telegraphic Cable.—From the *Scientific American* we learn that the recent attempt of the Great Eastern to lift and repair the Atlantic Cable of 1868 has failed, owing to stormy weather, and that the great ship has returned to England. The work will shortly be resumed. The fault has been located at a point not far eastward of the banks of New Foundland. The cable was successfully grappled and lifted several times. A portion of the original cable, that of 1858, was brought up during the grappling operations, and was found to be in a good state of preservation.

Iron and Steel Production in the United States.—From the recently published statistical report of the Secretary of the American Iron and Steel Association, we obtain the following information concerning this subject, which cannot fail to be read with interest.

There were produced in the United States in 1872 about 32,000 net tons of cast steel, and in 1873 there will be produced about 28,000 tons. In 1871 there were converted 45,000 net tons of Bessemer steel; in 1872, 110,500 tons; and in 1873 there will be converted 140,000 tons. About 85 per cent. of the Bessemer steel that is now converted in American works passes into rails.

The total quantity of pig metal converted in this country by the pneumatic process, in the year 1872, was 125,361 gross tons. During the first nine months of 1873, the total quantity converted was 127,384 tons.

The production of steel, in the United States, by the Siemens-Martin process agregated only a few thousand tons in 1872. The business was confined to seven establishments. As this quality of steel cannot be so cheaply produced as Bessemer steel, it is difficult to estimate the extent to which its production will be carried in future years, but we hear of one new enterprise in its manufacture having been inaugurated this year.

Bessemer works, for the conversion of steel and the rolling of rails, are now in operation at the following places; viz: Troy, N. Y.; Johnstown, Pa.; Harrisburg, Pa.; Bethlehem, Pa.; Newburg, Ohio; Chicago, Illinois (two separate establishments); and Joliet, Illinois. The Pennselvania steel works, at Harrisburg, are building a new plant, to be completed in 1874, which will double their present capacity. The Edgar Thompson steel works, near Pittsburg, Pa., are in course of erection, and, it is expected, will be finished in 1874.

The total capacity of the eight Bessemer steel-works now in operation is about 170,000 net tons of rails; to which add Edgar Thompson, and the new plant at the Pennsylvania steel works, and the total capacity of these works in the United States, at the close of 1874, may be placed at 224,000 net tons of rails.

Summary of Iron and Steel Production.—The following is a summary, in net tons, of the ascertained and estimated production of iron and steel in the United States, in 1872 and 1873:—

	1872.	1873.
Iron and steel rails, . .	941,992	850,000
Other rolled and hamered iron,	1,000,000	980,000
Forges and bloomeries, . .	58,000	50,000
Cast steel, ...	32,000	28,000
Bessemer steel, . . .	110,500	140,000
Siemens-Martin steel, . .	3,000	3,500
Pig iron, ...	2,830,070	2,695,434

A New Indicating Apparatus.—(WALTER HART, Philada).—This apparatus, for practical and experimental use as an attachment to boilers, stills, digesters and vacuum pans, is designed to be used by refiners, distillers and manufacturers of sugar, petroleum, spirits and other substances.

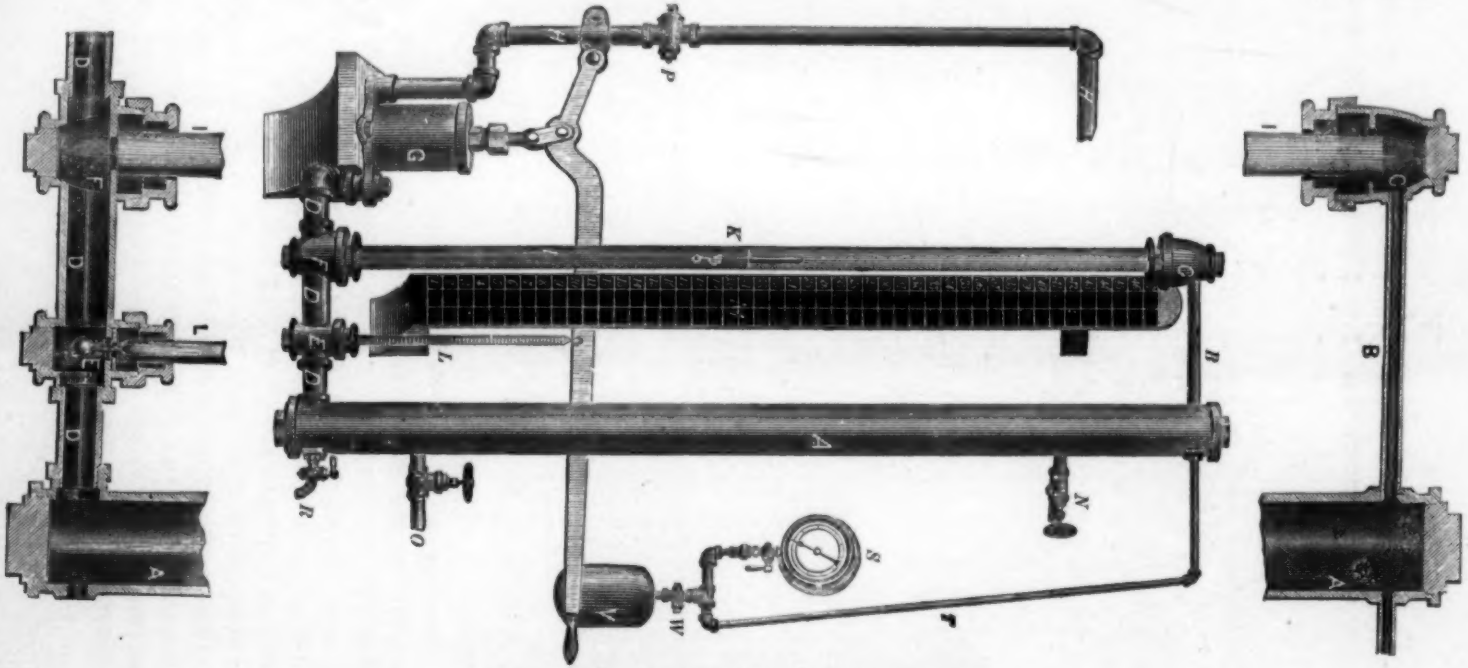
The apparatus is simple in construction and can be readily attached to any vessel, or still, in which liquids form the whole or part of the material being manufactured.

It is a novel combination of well-known instruments so arranged that it exhibits, under the same conditions as they exist in the vessel, the varying conditions of the material, so that at all times during the process of manufacture, the operator is informed concerning the following important points: Heighth or depth of material; the gallons in such quantities; the gallons in each inch and in any aggregate number of inches; temperature, both of material and its vapors; color and consistence; rate of evaporation and pressure of vapor.

Its construction, as shown by the accompanying views, consists of a metal tube, A (with arms, B and D), attached to the vessel, in which the manufacture is carried on, by connections entering the vapor or steam space and at the bottom, with such further intermediate connections as may be found desirable, the same being controlled by the valve, N, and cocks, O. A thermometer, L, in the lower arm, D; a scale, M, graduated in inches with spaces for the contents in gallons of each inch, and for the aggregate contents from the bottom upwards; a glass tube, I, of width sufficient to act as a hydrometer jar; a float, K (placed inside of I), which can be either an alcoholometer, saccharometer, or such other kind of instrument as the material may call for; a pump, G, also connected to the vessel; a pressure gauge, S, and cock, R.

The manner of working it is as follows: The valve, N, connected with the vapor space is opened, heating the apparatus; any of the cocks, O (if more than the bottom one) may then be opened, and the liquid allowed to flow in. The pump, G, is then worked, which will carry a continuous stream past a mercury vessel, in which the bulb of the thermometer, L, is set, such stream being kept up until the mercury in the thermometer ceases to rise, showing the maximum heat for the time being. Then cease working the pump, allow the glass tube to fill; the liquid, in finding its level, will carry the float, K, with it; by means of that, and of the thermometer, the true gravity is made apparent. The color can be seen through the tube; the quantity by the scale, M, at line of the lead of the liquid, the pressure by the gauge, S, while, if it is desirable to raise the material away from the vessel, it can be drawn through the cock, R.

The temperature, gravity, quantity, color, consistence and pressure having been taken all at the same time, under the same conditions, the contents of the apparatus are returned to the vessel by closing the cock, O, and working the pump, G. The operation can then be immediately repeated, a few minutes being only necessary for the operation.



A NEW INDICATING APPARATUS.

Tin Discoveries on Lake Superior.—Some time since, the technical journals very generally circulated a circumstantial account, detailing the discovery of abundant and valuable deposits of tin on the north shore of Lake Superior, and purporting to be the result of personal examination of the field. As nothing either confirmatory or contradictory of this account has since appeared, it may be of interest to state that a correspondent of the *Engineering and Mining Journal*, who recently resided in the region of the alleged discoveries, writes to the editor a letter, in which he casts the gravest doubts upon their genuineness, and intimates that the whole statement bears the appearance of having been a systematically devised attempt at swindling.

New Method of Mounting Stereoscopic Views.—By Professor Himes.—Instead of affixing the photographic prints to the usual stiff cards, they are mounted in a book, about $3\frac{3}{8}$ by $3\frac{1}{4}$ inches, on leaves of heavy paper of double that size, fastened by their centres on short guards, like maps in an atlas, each book containing about a dozen such double leaves. A piece of smooth paper is placed between the halves of each stereograph after mounting, and the book subjected to pressure, as of a copying press, for an hour or more. By opening such a book at any of these double leaves, and sliding it between the wire guards of a Holmes stereoscope, like an ordinary stereograph, an effect equal in all respects to that of the card stereograph is produced. Since the pictures can be readily examined by simply turning the leaves, and may be compactly stowed away, it is claimed that there is comparative freedom of the photographs from injury by mechanical, chemical, or atmospheric influences, whilst the facility of reference to any particular picture is greatly increased, especially when collections are properly arranged and classified; for which purpose each book is supplied with blank index and title pages. It is suggested that collections of stereographs on this plan, illustrative of different subjects, scientific and otherwise, or supplementary to books upon such subjects, might be placed in libraries, accessible to the public, with almost as little risk of injury as the books; a few simple instruments hung near such cases being the only addition necessary. The range of purely scientific subjects susceptible of stereoscopic illustration might increase under such encouragement.

The Artificial Production of Low Temperatures.—By Prof. Edwin J. Houston.—A need long experienced in science, viz: the

means of obtaining exceedingly low temperatures, seem at last to have been met by a German invention recently re-patented in this country. We allude to the "Windhausen Ice and Refrigerating Machine." Though introduced almost solely for practical purposes, mainly for the cheap production of artificial ice, the machine contains latent possibilities, which we hope will at once be utilized, that open up the most promising field to the original investigator, and bid fair to enrich science with stores of new facts.

Hitherto the lowest temperatures have been obtained through the rapid evaporation of solid carbonic acid dissolved in ether, or with liquid protoxide of nitrogen and bisulphide of carbon. These methods require much time, skill and caution, and are seldom employed. The Windhausen process, however, accomplishes the same result, with less trouble. A steam engine is employed to condense air to, say, two or three atmospheres. The heat developed by the compression is drawn off during the passage of the condensed air through pipes in a series of chambers, in which cold water is flowing. The cooled air is then allowed to expand into a cylinder under a gradually diminishing pressure, the expansion being attended with the development of great cold. It is claimed that under a pressure of but 85 pounds to the square inch, a reduction of — 54° F. has been obtained, a surprisingly low temperature, considering the means employed.

The following modifications of the apparatus would render its cold-producing power almost unlimited:—

1st. A communication between the expansion cylinder and the chambers through which the condensed air is conducted before it is allowed to expand. Supposing this outlet regulated by a cock, a blast of very cold air could replace the running water, and reduce the condensed air to a very low temperature.

2d. The introduction of a second compressing cylinder, with which the condensed air, after being cooled, could be still further compressed, again cooled, and finally conducted into the expansion cylinder. Under a pressure of, say, 60 atmospheres, a considerable mass of air at the temperature of say — 100° F. would, in its expansion, produce a reduction of temperature greater perhaps than any yet obtained. Since by means of the communication between the expansion and cooling chambers, the condensed air can be lowered to any temperature obtainable in the expansion cylinder, there would appear to be no other limit to the reduction of temperature save what would arise from the strength of materials, or the liquefaction and subsequent freezing of the nitrogen, or the oxygen of the air, or of the air itself.

Among the advantages that we may rationally expect to accrue from the apparatus thus modified, are the following:

1st. The confirmation or otherwise of the "absolute zero," as determined by the expansion or contraction of gases by heat or cold.

2d. The liquefaction and subsequent solidification of many of the incoercible gases, the determination of their physical peculiarities as liquids or solids, together with their crystalline form.

3d. The action of intense cold on the chemical affinities of certain gaseous compounds.

4th. The action of intense cold on the color of certain chemical compounds.—*Dept. Physics Central High School.*

Artificial Alizarine.—In substantiation of the growing importance of the manufacture of the artificial madder, referred to in a former item concerning the utilization of waste products, some remarks of Mr. J. W. Russell, before the Chemical Section of the British Association for the Advancement of Science, are directly to the point.

From his statements it appears almost certain that the industry of growing madder will shortly be extinguished altogether, and the lands and labor, now almost exclusively devoted to its cultivation in many parts of Germany and France, turned into other channels of production. Mr. Russell concludes his remarks as follows: "The alizarine mud, as I have called it, containing but tenper cent. of dry alizarine, is equal in dyeing power to about eight times its weight of the best madder, and is, moreover, the pure substances required for the dyeing in place of a complicated mixture (the natural madder) containing certain constituents which have a positively injurious effect on the colors produced. * * * * The demand for, and supply of, artificial alizarine are increasing at a most rapid rate, and yet its manufacture seems hardly to have commenced. The value of madder has much decreased; and, in fact, judging from what occurred in the year of revolution and commercial depression (1848), when the price of madder fell for a time to a point at which it was considered it would no longer remunerate the growers to produce it, that point has now again been reached, but certainly from a very different cause. Last year, artificial alizarine, equal in value to about one-fourth of the madder imported into England, was manufactured in this country. This year the amount will be much greater. Thus is

growing up a great industry, which, far and wide, must exercise most important effects. Old and cumbersome processes must give way to better, cheaper, newer ones; and, lastly, thousands of acres of lands, in different parts of the world, will be relieved from the necessity of growing the madder, and be ready to receive some new crop."

Iron Pyrites.—The *Polyt. Centralbl.* is responsible for the assertion, that iron pyrites may be so perfectly roasted as to retain only from one to two thousandths of sulphur, by roasting the ore, after having passed it once through Perret's roasting furnace, a second time, in a part of the same furnace, where there is fresh ore above and below it, which furnishes a high temperature in roasting. At the same time much more air must be given access to the ore, than in the first roasting. From the residue of the second roasting, it is said, a cast iron can be made, which is fit for use in the rolling mill.

Iron Electrotypes.—A brief item on this subject appeared in a former issue of the *Journal*, to which we may now add the additional declaration that M. Klein, a Russian chemist, has succeded in obtaining very satisfactory results from a series of experiments in this direction.

The process followed by him is described as follows: The bath employed consists of a concentrated solution of sulphate of iron and ammonia; and the battery of four Meidinger cells. For an anode an iron plate is used, with a surface about eight times that of the cathode, and connecting this with a copper plate, a perfect coating of iron is obtained. On leaving the bath, the iron, it is said, is as hard as tempered steel, and very brittle. When heated, however, to a cherry red, it is said to become malleable, and may then be engraved as easily as soft steel.

Gain in Weight by Combustion.—At a recent lecture before the Franklin Institute, Mr. Theodore D. Rand showed a simple and satisfactory experiment to demonstrate the increase in weight of burning bodies, caused by their absorption of oxygen. About an ounce of fine turnings of zinc, produced in the spinning of that metal, were loosely wrapped with iron wire and suspended from the arm of a balance. The pan on the other arm having been weighted to counterbalance the zinc, the latter was ignited with a match. At first the combustion was rapid, and much oxide escaped in fumes, causing the zinc end of the balance to rise. Soon, however, the combustion be-

came a mere glow, the absorption of oxygen taking place without fumes. In about a minute the beam began to descend and soon very decidedly outweighed the counterbalance.

The only precaution necessary is to have the zinc moderately but not too compact. If too loose it burns to rapidly, if too compact it will not burn.

The National Academy of Sciences.—The following details concerning the formation, character and duties of this eminent body of scientific men, from the *Acta Columbiana*, may have some interest.

"The National Academy of Sciences was created by Act of Congress of the United States, approved March 3, 1863, to serve as an authoritative adviser of the Government upon all questions relating to science. The words of the Act imposing this duty are the following: 'The Academy shall, whenever called upon by any department of the Government, investigate, examine, experiment and report upon any subject of science or art, the actual expense of such investigations, examinations, experiments and reports to be paid from appropriations which may be made for that purpose; but the Academy shall receive no compensation whatever for any services to the Government of the United States.' Practically, therefore, this body occupies the same position, as to scientific precedence, in this country as the Academy of Sciences of Paris, and the Royal Society of London, in France and Great Britain respectively.

"Many questions, among them some involving very laborious investigations, have been examined and reported on from time to time by Committees of the Academy, on the requisition of the several departments of the Executive Government, particularly the Departments of War, the Navy and the Treasury. Among them may be mentioned an inquiry into 'the best means of improving the navigation of the river and harbor of San Juan del Norte, in Nicaragua,' with a view of establishing a satisfactory inter-oceanic line of communication by that route. (This was before the opening of the trans-continental railroad.) Also inquiries into 'the galvanic action arising from the association of zinc and iron;' into 'magnetic deviations in iron ships;' into 'the best means of testing the strength of distilled spirits;' into 'the merits of various schemes submitted to the Treasury by inventors, for the protection of the paper currency against counterfeits;' and many others.

"Besides the reports to the Government, the Academy has made very numerous contributions to the advancement of science by the independent labors of its members, most of which have been published in scientific journals after having been read in the meetings; the pecuniary means at the command of the body not having sufficed to enable it to publish its own proceedings regularly in separate form. One volume was, however, published at the expense of the Government.

"By the Act of Charter, the number of members of the Academy was limited to fifty. On its own application this limitation was removed in 1871. The original corporators were named in the charter itself.

"Of the original members fourteen have been since removed by death, and five, at their own request, have been placed on the list of honorary members. The honorary members are Alexis Caswell, George Engelmann, Asa Gray, Joseph Leidy, and M. F. Langstreth; to whom are to be added Jas. P. Kirtland, a member since elected. One of the original corporators declined the nomination, and one other ceased to attend after the first meeting, and his name was dropped from the roll. There are now therefore only twenty-nine active members belonging to the original list.

"There have been added to the Academy by election, during the past ten years, fifty-three members, of whom six have died since their election, and one has been retired into the honorary list. There remain, therefore, of this number, forty-six active members, who, added to the twenty-nine original corporators, make the present total to be seventy-five. By a provision of the Constitution only ten additional members can be elected annually.

There have been also elected, since the foundation of the Academy eleven foreign associates, of whom four, viz: Sir Wm. Rowan Hamilton, Michael Faraday, Sir David Brewster, and Prof. G. A. A. Plana have died since their election.

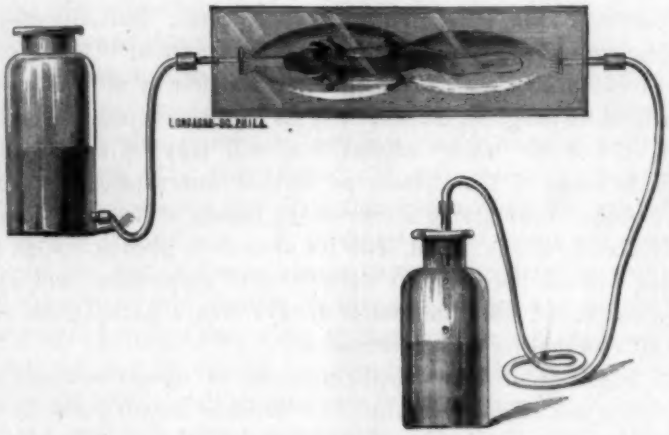
The Academy holds two *stated* meetings annually, one of which must be held in Washington, for the other the place is fixed by the Council. Scientific sessions may be called at any time and place, by a majority of the Council. The Council itself is a body composed of the officers of the Academy, and six other members elected for that purpose.

OPTICAL SECTION.

Proceedings of the Stated Meeting, November 24, 1873.

Several natural objects prepared for the microscope were furnished by Mr. T. W. Starr, of Philadelphia; also two delicate valves, made by Mr. Chabot, of this city, for preventing the gases used in combustion from mixing in their respective reservoirs, were shown attached to the elastic tubes.

The main subject of the meeting was the examination of Mr. D. S. Holman's "Siphon Slide," an engraving of which is herewith shown.



This invention presents a modification of the chamber of Mr. Holman's former device, known as the "Life Slide." It has fine perforations at each end of the chamber, too small to permit the escape of the animal under view, but sufficient to maintain a flow of water. These openings merge into cylindrical mouths, to each of which is attached a tightly-fitting elastic tube; one of these communicates with the reservoir of water, while the other acts as an escape conduit. The position of the slide, when in use, must be slightly *above* the level of the reservoir, while the escaping tube must rest *below* the reservoir; thus insuring a veritable siphon action in the apparatus, a constant flow of water being thus secured, in connection with the required atmospheric pressure for the retention of the cover of the slide. By this ingenious device, living aquatic animals may be retained in the chamber in a natural condition for hours, and even days.

Mr. Holman reported that he had exposed a young larva of Salamander, for an hour, to the full influence of the oxyhydrogen light, with no apparent injury to the subject.

By a critical watching of the screen, the circulation of the blood in the minute arteries of the animals was clearly visible to the members —a result, it is believed, never hitherto presented to an audience during such an extended period of observation.

The lantern, as a whole, is the work of Mr. Joseph Zentmayer, also a member of the Section, who, besides building the various parts with his peculiar exactness, furnished with it a lens of eight-tenths of an inch in focus, of a novel construction.

[COMMUNICATED.—The "Holman Siphon Slide," partially described in the minute of the Recorder of the Optical Section of the Institute, is an invention the want of which has been felt by all teachers and students in histological studies. By its means a constant current of either cold or hot water, adjustable at will, may be caused to flow across the stage of the microscope without interruption for hours or days together, thus giving a convenient means of leisurely studying the circulation of the blood, with its attendant phenomena, in many animals, without the slightest exhaustion of respiration, and without *curara* or *chloral*, which narcotics always create pathological conditions unfavorable for such observations.

The migration of white-blood corpuscles in tissues not mutilated, the phenomena of inflammation, the delicate nerve fibres in *living* tissues, living epithelium, and many types of aquatic respiration, fresh-water or marine, are all brought within easy study of every teacher or student.

I have had under observation for a week, in one of these slides, a larva of a Chironomida, and besides the beautiful spectacle of its blood-red organization, I was able to watch its habit of weaving a silken tube under water in order to inhabit it for protection against its enemies.

When opticians shall give us lenses of power and light enough to be used successfully in the oxyhydrogen or electric lantern, this contrivance will render it possible to keep even a living trout, just hatched from the egg, under the beam of illumination for hours, if desirable, without exhaustion, because a constant current of ice-cold water may be drawn over the animal by the siphon action of the slide.—J. G. H.]

Civil and Mechanical Engineering.

TEST OF A STATIONARY ENGINE.*

A few preliminary remarks on the test described in the accompanying report may not be out of place. A pair of high pressure engines—diameter of cylinders, 20 inches; length of stroke, 4 feet—were fitted with a patent condenser, under the guarantee that several tons of coal would be saved per week, it being understood that all leaks of joints, valves, pistons, etc., were to be repaired by the proprietor. An inspection of the coal account, after the condenser was attached, showed that the consumption of coal was increased, and the engineer insisted that there were no leaks, and that the whole fault was with the condenser. The condenser in question has already obtained considerable reputation, and is in use in various parts of the country, giving good satisfaction. It was necessary, however, to bring facts to bear in a case like this, and to show the existence of leaks beyond controversy. In this regard, the report will speak for itself, the test having determined an enormous drain of steam, palpable to the senses, and capable of being measured and weighed. It scarcely ever happens that users of steam power are not amply repaid for the cost of careful investigations, and this report is published in the hope of calling attention to the importance of such tests. There is a tendency among persons who are proud to call themselves "practical" to decry all theory, but we think the reader will find the accompanying remarks quite practical enough, since they contain suggestions readily appreciated by the most practical man, in reference to the folly of generating steam by the consumption of fuel merely to blow it away without using it. If a man were to get up a high pressure of steam in a boiler for the pleasure of seeing it escape through the safety valve, his acquaintances would have their opinion of his sagacity. How many to-day are doing essentially the same thing, unwittingly:

80 Broadway, New York.

Henry L. Brevoort, Esq., New York: Sir.—As requested by you, I visited the works of the Peters Manufacturing Company, at Newark, N. J., on the 18th and 19th instants, and made careful tests of

*From The Iron Age.

the engines, to discover if there were any leaks or other derangements. On the 18th inst. the condenser was used, and on the 19th it was detached, the steam from the engine being allowed to exhaust into the atmosphere. In making these tests I took 12 indicator diagrams each day (3 from each end of each cylinder), at suitable intervals, so as to obtain average conditions. I also noted down various other data, as will appear in the course of my report. According to memoranda furnished to me, the consumption of coal for three days, when the condenser was in use, was at the rate of 14,667 pounds per day—and for three days when the condenser was detached, at the rate of 12,667 pounds per day—showing a gain in fuel by taking off the condenser of 15·79 per cent.

During the two days I was at the works, the conditions, in regard to the power developed by the engines, were nearly identical, an average of all the cards taken on the 18th instant, when the condenser was attached, giving a mean pressure on the piston of 30·9 pounds per square inch, and 199·6 indicated horse-power, while on the 19th instant, when the condenser was taken off, the average mean pressure was 29·0 pounds per square inch, and the indicated horse-power 198·44.

I have taken from the cards the amount of steam used per indicated horse-power per hour, adding to those taken on the 18th instant the amount of steam used by the air-pump. In making this calculation I have used the pressure of the steam in the cylinder, as shown by the cards, at the time the exhaust valves opened, and have multiplied the number of strokes made by the pistons per hour by the volume of that portion of the cylinders swept through by the pistons, from the commencement of stroke to point of exhaust (in cubic feet with clearance added), and by the weight of a cubic foot of steam at the given pressure, thus obtaining the number of pounds of water, in the form of steam, used by the engines per hour. The cards, of course, do not show all the steam used in the cylinders, as they do not give the amount of water in the steam, the amount of radiation and condensation, and the amount of steam that leaks past the valves when the cylinder is opened to the exhaust. But under the present circumstances they give good comparative results.

As shown by these calculations, the amount of water per indicated horse-power per hour (adding that required to work the air-pump), on the 18th inst., was 23·18 pounds. On the 19th inst., the amount of water required per indicated horse-power per hour was 26·98 lbs.

According to this, it appears that the engines, when exhausting into the air, required an evaporation of 16·39 per cent. more water to enable them to do the same work as when using the condenser, and did this with 15·79 per cent. less coal.

A conclusion so anomalous could only be reached by ignoring the question of leaks around the engines, unless the loss was caused by some defect in the condenser.

There are only two ways in which the use of the condenser could occasion a waste of fuel: 1st. By creating additional back pressure, instead of lessening it. 2d. By using more power to work the air-pump than would compensate for the vacuum produced. I will examine both of these points.

From the indicator cards taken, the mean pressure per square inch, due to a vacuum when the condenser was in operation, was ascertained to be 5·14 pounds, and the mean back pressure per square inch 2·29 pounds, so that the condenser, instead of increasing the back pressure, reduced it to the extent of 7·43 pounds per square inch, or at the rate of 24·44 per cent. of the total mean pressure on the pistons.

In regard to the second point, the average speed of the air pump was 136 strokes per minute, and calculating from its piston displacement, the most water it could have delivered in that time was 6181·5 pounds. This water had to be lifted a distance of 14 feet, so that the work required from the pump, at its maximum, would be about 2·62 nseful horse-power. As will appear further on, very much less than the maximum quantity of water was actually delivered by the pump.

When the engines were running without the condenser, the steam was exhausted through three feed water heaters, thereby increasing the amount of back pressure. Credit should be given for the increased heat of the feed water, since, when the condenser was in use, the exhaust steam only passed through one heater, and the feed water did not have so high a temperature. Means of a number of observations of the temperature of the feed, gave the following results:—

June 18, ...	141·5°
June 19, ...	169·4°
Difference, ...	27·9°

The amount of gain from the increased heat of feed water is readily calculated. The mean pressure of the steam per gauge, on the 19th

instant, was 80·6 pounds per square inch. Steam of this pressure has a total heat of 1209·3.° Hence with the feed water at 141·5°, a pound of water must have 1067·8 units of heat imparted to it by the fuel to be converted into steam, and when the feed water is at 169·4° it will require 1039·9° units of heat. The per cent. of gain by the increased heat of the feed water will be

$$\frac{(1067.8 - 1039{\cdot}9) \times 100}{1067{\cdot}8} = 2{\cdot}67.$$

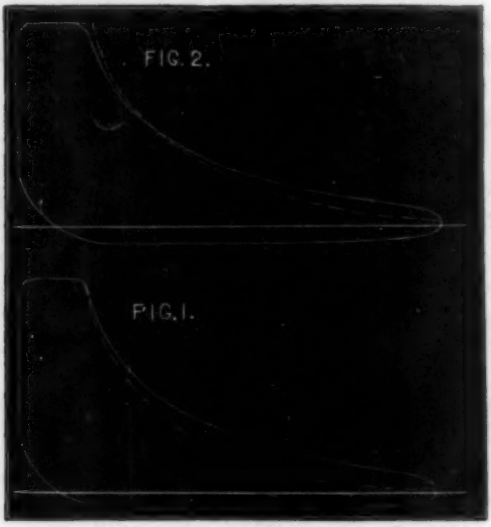
The gain by the use of this arrangement of heating feed water is somewhat questionable. The back pressure produced by exhausting through the heaters, is 2·29 pounds per square inch, or 9·7 per cent. of the total mean pressure on the pistons, and produces a saving of 2·67 per cent. In other words, nearly 10 pounds of coal are burned in order to save 3.

It will be advisable, then, to return to the engines, and endeavor to discover leaks of steam. It must be evident that if valves and pistons are tight there can be no steam admitted to the cylinder after the steam valve has closed, nor can any be lost from it until the exhaust valve is opened, and under ordinary circumstances the indicator will show if these conditions obtain in actual practice. I give a tracing of an indicator diagram (Fig. 1), taken on the 18th inst., and have added a dotted line, showing approximately the form of expansion curve if valves and pistons had been tight.*

The marked difference between this curve and the one actually produced is still more noticeable in most of the other diagrams, showing conclusively the existence of an excessive leak either in steam valve (Fig. 2), or in joint of steam chest. Below will be found a tracing of the same diagram, with a dotted line, showing the form of expansion curve, with valves, etc., in good condition, the mean pressure on the piston being the same in the actual and theoretical diagrams. Mere inspection of this card will show that the same amount of work will be done with far less steam, if the card is taken as marked by the dotted line, and a calculation gives 18·37 per cent. less steam to do the same work, if the engines performed as indicated by the dotted line.

* As is well known to engineers that, even if valves and piston are tight, the actual curve of expansion may be higher than the theoretical, owing to condensation and re-evaporation, or from the presence of a large quantity of water in the steam, I would not so confidently have attributed the difference in this case to leaks, unless subsequent tests (as shown in the report) had confirmed this view.

But this waste of steam is small in comparison with that lost when the engine is exhausting. If there is a leak of valves or steam chest while the cylinder is taking steam, this becomes far worse when the pressure is diminished by the exhaust. A good idea of the state of things existing in these engines can be obtained by imagining a steam pipe to be tapped into the cylinders for the purpose of admitting steam continually, during both the periods of admission and exhaust in the cylinders.



The steam valves of these engines close quickly, and it is easy to calculate the difference in the amounts of steam in the cylinders at points of cut-off and exhaust. The mean of all the diagrams shows a difference of 75·5 per cent., or, in other words, that while the pistons are moving from point of cut-off to point of exhaust, 75·5 per cent. as much of steam leaks in as was previously admitted. Of course when the exhaust valve is opened a still greater leak takes place under the diminished pressure. Fortunately I was able to determine the amount of this leak (which the indicator does not show) quite accurately.

On the 18th instant, while the engines were stopped, a simple test showed that the pistons were not tight, but the amount of leak from that cause is not to be compared with the one already pointed out. So large a leak can hardly be due to the improper fitting of the steam

valves, and I am of the opinion that it will be found in some portions of the steam chests which have several internal joints.

I will now describe the method by which I ascertained the amount of leak that occurred during the exhaust. When the condenser was in operation the condensing water and the condensed steam were discharged by the air pump into a large tank. This water entered the condenser at a temperature of 71°, and was discharged at a temperature of 124·5°, having acquired 53·5° from the condensed steam. I obtained the quantity of water discharged by the air pump per minute by observing the time required to fill a tub of known dimensions held under the discharge pipe. An average of seventeen careful experiments of this kind gave the time of filling the tub as 3·37 seconds, and, in addition, some little water splashed over at each experiment, owing to the violence of the discharge. I certainly err on the side of safety in assuming the time as 3½ seconds. The capacity of the tub was 4521·37 cubic inches, which would give a discharge per minute of 335·5 gallons, or 2792·19 pounds. Somewhat more water per minute was undoubtedly discharged, but in the absence of exact measuring apparatus, a perfectly safe estimate, assuredly within the limits, seems advisable. Good steam pumps will deliver from 90 to per cent. of the quantities due to the displacement of pump pistons, and the quantity I have taken is only about 45 per cent. of the maximum.

The calculations of the amount of steam used, from measurements of the quantity and temperature of the discharge water, is one of the most elegant and accurate tests of the efficiency of an engine; and it is rarely that so good an opportunity for obtaining these data is secured without considerable preparation.

The amount of water delivered per minute, as before remarked, was 2792 19 pounds, and its temperature was raised 53·5°. The method of obtaining the amount of steam used by the engines per minute from these data is as follows:

Let X = pounds of steam used per miuute.

Let W = pounds of condensing water.

Then from the observation,

$$W + X = 2792{\cdot}19.$$

$$W = 2792{\cdot}19 - X.$$

The steam at the point of exhaust had a mean pressure, as shown by the indicator diagrams, of 19·5 pounds per square inch, so that each pound of steam contained 1183·1 units of heat. When con-

densed the temperature of this steam was 124·5°, so that each pound had imparted 1183·1 — 124·5 = 1058·6 units of heat to the condensing water, and by this means had raised its temperature 53·5°.

From these considerations an equation can be formed, and the amount of steam used per minute determined.

X × 1058·6 = units of heat lost by the steam.

W or (2792·19 — X) × 53·5 = units of heat imparted to condensing water.

And as these must be equal

X × 1058·6 = (2792·19 — X) × 53·5.

Whence

X = 134·32.

This 134·32 is the number of pounds of steam used by the engines and air pump per minute, and we must next ascertain the amount of steam used by the air pump. The useful work of the air pump is the lifting of 2792·19 pounds of water 14 feet high per minute, which amounts to

$$\frac{2792.19 \times 14}{33{,}000} = 1{\cdot}18 \text{ horse power.}$$

Beside this useful work, the pump must overcome the friction of its moving parts, and the friction of the water in the passages. At a careful test of steam pumps at the fair of the American Institute in 1867, the Knowles pump gave an efficiency of 44·38 per cent., one pump of another make giving as low an efficiency as 18·33 per cent. I will assume this lowest efficiency for the present case. On this supposition, to produce 1·18 horse-power of useful work, the pump must have an indicated power of

$$\frac{1{\cdot}18 \times 100}{18{\cdot}93} = 6{\cdot}653.$$

(It is proper to remark here that, according to the efficiency of this pump, as shown by experiments, the indicated horse-power would only need to be 2·66, and it will be evident that I have allowed an excessive margin of safety). The mean pressure of steam required to produce this horse-power at the speed at which the pump was working, is 15·12 pounds per square inch, and allowing a back pressure on the piston of 9 pounds per square inch, the pressure per gauge should be 24·12 pounds—say 25.

On this assumption the pump would require 6·49 pounds of steam per minute, which is an allowance of nearly a cubic foot of water per

indicated horse-power per hour. The amount of steam used by the engines per minute will then be 134·32 — 6·49 = 127·83. According to the indicator diagrams, the amount of water used by the engines per indicated horse-power per hour was 21·23 pounds, and this calculation shows the amount actually used to be 38·43 lbs., giving a leak while the engines were exhausting of 81·02 per cent.

This is quite sufficient to account for the apparent paradox mentioned in the first part of this report, of the engines, when the condenser was detached, using more steam and burning less coal. I had no means of ascertaining the amount of steam that leaked during the exhaust, when the engines were disconnected from the condenser, but of course it would be less than when the condenser was in operation, since in the latter case the pressure of the exhaust was much diminished.

It is a matter of surprise that the condition of affairs was not discovered long ago by a simple inspection of the coal account. Here is a case in which, under the most moderate estimate, 50 per cent. of the effect of the fuel has been passing silently away, unseen and unsuspected, without doing any useful work. It is another illustration of the fact which is so frequently demonstrated, that users of steam power cannot employ too many checks to prevent and discover waste; and it is a strong tribute to the value of that useful instrument—too often despised by the so-called practical man—the steam engine indicator. I assume that the owner of these engines will seize the first opportunity to have this great leak stopped, and I am confident that when this is done, he will realize the full benefit claimed by you for the application of the condenser I must add, before closing, that I have carefully examined the construction and operation of the condenser, in connection with my inspection and test of the engines, and t gives me pleasure to state that it seems to be well designed and constructed, and of ample proportions.

Respectfully, RICHARD H. BUEL.

June 24, 1873.

ON THE STEAM BOILER EXPLOSION ON THE FOURTH AVENUE, BETWEEN 128TH AND 129TH STREET, N. Y.

By W. Barnet Le Van, Engineer.

At the time of the explosion the boiler stood in the middle of the roadway between 128th and 129th street, on Fourth Avenue.

It was attached to a hoisting machine, and the men employed upon it were in the act of moving the apparatus further up the street.

The whole apparatus, boiler and hoisting machine, stood on a wooden platform, supported by heavy broad tread wheels. It was used in hoisting earth from the excavation and depositing the same on the bank above.

The explosion occurred about four o'clock P. M., on Tuesday, November 11th, 1873, killing seven persons and wounding nine others.

Very considerable damage was done to the houses in the neighborhood by the concussion and flying missiles. The windows of every store and many of those of the residences above them along the block facing the boiler were broken, shutters were torn asunder and their fragments scattered broadcast. Broken glass and fragments covered the sidewalks, and such of the shopkeepers as had whole shutters closed their places.

The exploded and mutilated boiler was found amid beams and broken timbers, a chaos of woodwork that told a tale of recent disaster.

The boiler is what is known as a vertical tubular, consisting of a shell about 6 feet in height and 44 inches in diameter, made up of two rims, the thickness of which, as well the heads, was No. 4 = to .238 inches.

It differed somewhat from the ordinary upright boiler, in having two systems of tubes; the lower set consisting of a cluster of forty-two water tubes, each two inches in diameter and twenty-five inches long, connecting the front and back water-spaces, passing directly above the fire, from front to rear, and placed about five-eighths of an inch apart and staggered so that the hot gases in passing up between impinge on them. The vertical fire tubes, thirty-six in number, two inches in diameter and seventeen inches long, connected the upper end or crown sheet of the furnace with chimney. Through these tubes the products of combustion passed, after passing between the water tubes below; the upper flue sheet was stayed to the top rim by braces about eight inches apart, in it was placed the man-

hole, strengthened by a cast-iron rim riveted to it and fitting the cover.

It had two gauge cocks, the bottom one about three inches above the top, also one safety valve, one and one-half inch diameter.

The water was carried in the boiler so as to cover the lower flue sheet of the upper fire tubes, (it was claimed that the water could be carried much lower without danger of burning out the crown sheet, because the heat was so exhausted by the water-tubes, before passing them, that it could not injure the tube-sheet above.)

The condition of the boiler after the explosion shows the crown-sheet of the furnace and all the vertical fire-tubes to be in good condition, and does not indicate overheating, except at the extreme upper ends. The vertical tubes are in the same position as when first placed in the boiler, with the exception of the flanged ends securing them to the upper tube-sheet, which are straightened out and drawn a little to one side by the withdrawal of the tube-sheet from them.

From an examination of the portion of the boiler remaining in its original position, it parted on a line of the caulking of the seam that joined the two rims together, starting on the back side of the boiler and following in a horizontal line two-thirds of the circumference and running in to the front sheet as shown in the cut.

The weakest part of the boiler was at the point of the commencement of the rupture; the boiler-maker, in caulking this seam, indented the sheet with his caulking tool to the depth of at least one-thirty-fourth of an inch, reducing thereby the thickness of the plate. The line of the fracture follows this indentation all the way.

Pieces of the shell and upper flue sheet, thrown upward and two blocks distant, went through the roof of a house and lodged in the top story; the balance, consisting of braces and smoke-box, were thrown in all directions.

One of these projectiles was thrown towards one hundred and twenty-seventh street, and struck a young lady, Miss Louisa Bassford, aged eighteen, killing her instantly. She fell on the sidewalk where she stood at the moment of receiving the blow. The upper half of her skull was carried some ten feet distant; her head was literally cut in two. A little Italian girl, Irene Benetre, aged twelve, carrying a harp across the bridge at one hundred and twenty-eighth street, was killed about midway in her passage over the avenue; William Britt, ten years of age, on his way home from school, met his death

in the same place; as did also four of the men employed on the work. Curiously enough, all the killed and wounded were struck in the head.

From all the information that could be obtained, it was shown that prior to the explosion there was about forty pounds pressure of steam per square inch on the boiler, water to the second gauge cock had been pumped in some twenty minutes, and the furnace door was open. The engine was at rest, and the whole apparatus had been moved about ten feet.

The Engineer's Statement.—John Barnum, the engineer, said: I have had fifteen years experience; I was licensed two months ago; I passed an examination before I received my license. The boiler exploded about four o'clock; I was at 129th street, coming toward it. About twenty minutes to four, I was at the boiler and pumped it up. I threw the fire door open. The boiler was in good condition to be moved. Never had orders to stand by the boiler while it was being moved. I consider the moving perfectly safe. There was no crack in the boiler that I could see. When I left the boiler the gauge showed fifty pounds. The steam and water gauges were in good condition.

John Daggert's, (the man in charge of the hoisting machine), statement.—Two weeks before the explosion I was set to work at the hoister. I was placed under the orders of John Barnum, the engineer, and the machine was never moved except at his direction. Before the machine was moved that afternoon, Barnum said the boiler was all right. When the explosion came, I was standing still, having moved the machine about ten feet. There were a number of workmen around the boiler; I was about four feet from it. I heard a great noise. It was the work of a moment. If buildings had fallen over my head and been smashed to pieces, that would have been as near as I could come to a description of the explosion. I was knocked down. I don't remember anything else until somebody lifted me on my feet; then I found my coat was saturated with steam and I was scalded about the neck. I saw some dead bodies on the ground, one on each side of me. My foot rested on one of them.

In reply to the foreman of the jury, the witness said: I don't think there was any fuel put in the fire box just previous to the removal of the boiler; the fire door was open; I saw it; that was to stop the draught and let the fire go down. Just previous to the explosion I tried the water gauge, and found water in the upper gauge cock; as

far as I remember, the pressure was forty pounds just before the explosion; I saw it on the steam gauge. The last thing done previous to the removal was to pump water into the boiler. Barnum left me about fifteen minutes before the accident; when we were at work, the pressure on the boiler was sixty or seventy pounds.

The cause of the explosion was over-pressure.

It is a well-known fact that all water is surcharged with atmospheric air; the effect of this air in the water is that it promotes the ebullition pushing the atoms apart, as it were, and aiding them to take the gaseous form. Water freed from air by long boiling has its cohesive character entirely changed, thus removing the air cushion which separates the atoms; this is demonstrated by the water-hammer, of every day occurrence, in the water-pipes of our houses on the sudden shutting off of a stopcock, showing how it assumes almost the character of a solid.

Water thus freed of its air may be raised more than 100 degrees above the boiling point without ebullition.

When ebullition does take place in water so freed of air—it having an enormous excess of heat stored up—it is converted into explosion like the violent breaking of a spring under strong tension.

We can compare the presence of heat stored up as latent in a body of water to a bottle of soda charged with carbonic acid gas, the gas being held down by the attraction of the atoms of the water is not readily discharged without an agitation of the bottle. Pour the soda into a tumbler, when it has subsided dash in some fine sand, and a violent effervescence is due entirely to a mechanical disturbance.

Now, applying this to the boiler before us, it had been standing still for a long time, no doubt sufficiently long to expel the air contained in its water; *that* liquid would possess, in a greater or less degree, the high cohesive quality to the above.

Now by the moving of this boiler over the rough road-way, jolting it would have a tendency to lift the safety-valve, thereby disturb the attraction of the liquid particles for each other, and steam of explosive force would instantly be generated.

That there was at the time of rupture an excessive pressure in the boiler, the condition of the remaining portion is the best evidence. Not one of the vertical tubes are distorted in the least; they remained perfectly perpendicular as when first placed in the boiler, in fact all the parts remaining are as perfect as when first made.

The boiler inclines toward 129th street, showing that the weakest

part of the shell was on the back side, the front side being the stronger, as shown by the irregular fracture which caused it to incline up the avenue.

DESCRIPTION AND DUTY OF THE LYNN PUMPING ENGINE.

The following communication from a correspondent, is a description of the engine now in operation at the water works of the city of Lynn, Massachusetts.—ED.

Description of the Pumping Engine.—The economy of the Lynn pumping engine has exceeded all machines of its class hitherto constructed in this country. On account of its novel design and many peculiarities of construction, we will give a short description of its operation. The cylinders are placed in the central part of the engine, and connect with the extremes of the walking beam; the pump is located directly under one end, and the crank, connecting with the fly wheel, beneath the other. This arrangement allows the stroke of both cylinders, the pump and the throw of the crank to be of the same length, therefore all the reciprocating parts move with the same velocity, and their momentum is exactly proportional to their weight —a method of construction which is philosophical in principle. This arrangement reduces the strain on the various parts of the machine, diminishes the friction, and permits a reduction of the weight of matter used in construction. It also contributes largely to the steadiness of motion. A series of computations show the stress on the walking beam to be only twenty-five per cent. of what it would be were the cylinders and pump arranged as is customary in such engines.

The steam from the boiler passes into the high-pressure cylinder, and when the piston has advanced one-third of its full stroke, the port is closed, and the steam impels the piston by the gaseous property of expansion, its volume being increased three times, and the pressure diminished proportionally. When the stroke is finished, the steam passes into the low-pressure cylinder, which is nearly four and one-fourth times as large, and operates in a similar manner; thence it goes into the condenser. In passing through the two cylinders the steam is expanded twelve and three-fourths times its original volume.

By an indicator diagram, taken by the writer, the mean pressure on the piston of the high-pressure cylinder was found to be forty and eight one-hundredths pounds per square inch, while that on the piston of the low-pressure cylinder amounted to twelve and eight one

hundreds pounds per square inch; but on account of the increased capacity of the low-pressure cylinder, the total pressure was twenty-four thousand four hundred and sixty-three pounds, being nearly thirty-five per cent. more than that on the high-pressure cylinder, which amounted toeighteen thousand one hundred and fifty-six pounds. The cylinders are surrounded by steam jackets, and are further protected from a loss of heat by radiation by a covering of asbestos. Outside of this is a casing of black walnut.

The horse-power of the engine varies from ninety to two hundred, according to speed. The small pumping engine in the boiler-room, which is judiciously kept there as a reserve in case of accident, consumes from six to seven times as much coal as the large engine when doing the same work. The pump throws one hundred and ninety-four and ninety-three one-hundredths gallons per stroke into the reservoir, which is one hundred and fifty-seven and six-tenths feet above the surface of the water in the pump well.

The duty of an engine is the measure of its economy, and consists of the number of pounds of water raised one foot high by the consumption of one hundred pounds of coal. To substantiate the claim made in the first part of this article, we give the duties of such city pumping engines as we are enabled to from the various reports in our possession. When a test has been made by a board of expert engineers upon any engine, the results obtained should be taken in preference to those contained in the report of those having the charge of the engine. The report of a board of experts generally exceeds the monthly duty of an engine by about twenty-five per cent., because in the latter case coal is used in starting and banking fires, also for heating the building.

The highest duty given by the Lynn engine took place between June 27, at six o'clock A. M., and fifteen minutes past eleven on the following day—twenty-nine and one-fourth consecutive hours—during which the engine made twenty thousand four hundred and forty revolutions, and consumed fifty-four hundred pounds of coal. The duty for the five months ending September 30, including coal used for starting and banking fires, amounted to seventy-nine millions. The following table gives figures confirming our statements:

Place.		Pounds.
Cincinnati, No. 6,	Trial	22,937,747
	Year 1871	21,439,332
Boston Highlands, Year 1872		22,770,000

Cincinnati, No. 5.	Trial	32,946,758
	Year 1871	30,794,446
Cincinnati, No. 4,	Trial	34,053,856
	Year 1871	31,829,288
Louisville, Year 1871		36,915,404
Salem, Year 1872		36,061,926
Cincinnati, No. 3,	Trial	38,976,138
	Year 1871	36,430,022
Cleveland, Year 1871		40,941,937
Chicago, Year 1871		44,465,198
Cambridge, Year 1872		39,008,782
Cambridge, March, 1873		52,000,000
Phila. (Belmont)	Trial	54,416,694
	Year 1872	41,000,000
New Bedford, Trial		59,336,497
Brooklyn, No. 1, Trial		61,111,400
Charlestown, No. 3, November, 1872		62,069,280
Charlestown, Nos. 1, 2 and 3, Year 1872		54,259,482
Brooklyn, No. 3, Trial		72,000,000
Lowell, Trial		93,002,272
Lynn, five months		78,865,000
Lynn, June 27 and 28		99,428,000

CIVIL ENGINEER.

THE PRINCIPLES OF SHOP MANIPULATION FOR ENGINEERING APPRENTICES.

BY J. RICHARDS, Mechanical Engineer.

[Entered according to the act of Congress, in the year 1873, by John Richards, in the office of the Librarian of Congress at Washington.]

(Continued from Vol. LXVI, page 395.)

SHAFTS FOR TRANSMITTING POWER.

There is no use in entering upon explanations of what the learner has before his eyes. He sees shafts wherever there is machinery; he may also see the extent to which they are employed to transmit power, and the usual manner of arranging them; he can read in various text-books of the exact data for determining the amount of torsional strain that shafts of a given diameter will bear; that their capacity to resist torsional strain is as the cube of the diameter, and that the deflection from transverse strains is so many degrees, with many other matters that are highly useful and proper to know. I will therefore not devote any space to these points here, but treat of some of the more obscure conditions that pertain to shafts, such as

are demonstrated by practical experience rather than deduced from mathematical data. What is said will apply especially to what is termed line-shafting, for conveying and distributing power in machine shops and other manufacturing establishments.

The strength of shafts is governed by their size and the arrangement of their supports.

The capacity of shafts is governed by their strength and the speed at which they run, taken together.

The strains to which shafts are subjected are the torsional strain of transmission, transverse strain from belts and wheels, and strains from accidents, such as the winding of belts.

The speed at which shafts should run is to be governed by the nature of the machinery to be driven and the nature of the bearings in which the shafts are supported.

As the strength of the shafts is determined by their size, and the size fixed by the strains to which the shafts are subjected, the strains are to be first considered

There were three kinds of strain mentioned—torsional, deflective, and what was termed accidental strains.

To meet these several strains the same means has to be provided, which is a sufficient size in the shafts to resist them; hence it is useless to consider each of these different strains independently. If we know which of the three is greatest, and provide for that one, the rest of course may be disregarded. This, in practice, we find to be the accidental strains to which shafts are subjected, and they are always made in point of strength far in excess of any standard that would be fixed by either the torsional or transverse strain due to the regular duty the shafts have to perform.

This brings us back to the old proposition, that for structures that do not involve motion mathematical data will furnish dimensions, but the same rule will not apply in machinery.

Experience has demonstrated that for ordinary cases, where the power transmitted is applied with tolerable regularity, that a shaft three inches in diameter, with its bearings four diameters in length, placed ten feet apart, and running at a speed of one hundred and fifty revolutions a minute, is a proper size to transmit fifty horse-power.

The apprentice, by assuming this or any well-tried example, and estimating larger or smaller shafts by keeping their diameters as the cube root of the power to be transmitted, the distance between bearings as the diameter, and the speed inversely as the diameter, will find

his calculations to agree with the modern practice of our best engineers.

Shafts as a means for transmitting power afford the very important advantage that power can be easily taken off at any point throughout their length by means of pulleys or gearing, also in forming a positive connection between different machines.

Shafts are also the cheapest means of transmitting power within limited distances.

The capacity of shafts in resisting torsional strain is as the cube of their diameter, and the amount of torsional deflection in shafts is as their length.

The torsional capacity being based upon the diameter, often leads to what may be termed tapering shafts, lines in which the diameter of the several sections are diminished as the distance from the driving power increases, and as the duty to be performed grows less.

This plan of arranging line shafting has been and is yet quite common, but certainly was never arrived at by any of the processes of reasoning that have been so continually alluded to in the course of this treatise.

Almost every plan of construction has both its advantages and disadvantages, and the best means of determining the excess of either, in any case, is to first arrive at all the conditions, as near as possible, then form a "trial balance," putting the advantages on one side and the disadvantages on the other, and foot up the sums for comparison.

Dealing with this matter of shafts of uniform diameter and shafts of varying diameter in this way, we find in favor of the later plan a little saving of material and a slight reduction of friction, as advantages; the saving of material relating only to first cost, because the cost of fitting is greater in constructing shafts when the diameters of the pieces are varied; the friction, considering that the same velocity throughout must be assumed, is scarcely worth estimating.

For disadvantages, there is the want of uniformity between fittings that prevents their interchange from one part of the shaft to the other, a matter of great importance; a shaft, when constructed in this way, is special machinery, adapted to some particular place or duty, and not a standard product that can be regularly manufactured as a staple, and thus afforded at a low price. Pulleys, wheels, bearings and couplings have to be all specially prepared, and, in case of change or extension of lines of shafting, causes annoyance, and frequently no

little expense. The bearings, besides being of varied strength, are generally in such cases placed at irregular intervals, and the lengths of the different sections sometimes varied to suit the diameter of the shafts.

Going next to shafts of uniform diameter, everything pertaining to the line is interchangeable; the pulleys, wheels, bearings or hangers can be placed at pleasure, or changed from one part of the works to another. The first cost of a line of shafting of uniform diameter, strong enough for a particular duty, is generally less than that of one consisting of sections that vary in size, and all the objections of diminishing that have been named are avoided.

I have called attention to this case, as one wherein the conditions of operation obviously furnish the true data to govern the construction of machinery, instead of the strains to which the parts are subjected, and as a good example of the importance of analyzing mechanical conditions.

If the general diameter of a shaft was predicated upon the exact amount of power to be transmitted, or if the diameter of a shaft at various parts was based upon the torsional stress that would be sustained at those points, such a shaft would not only fail to meet the conditions of practical use, but would cost more by such an adaptation.

The regular working strain to which shafts are subjected is inversely as the speed at which they run; a strong reason in favor of arranging shafts to run at a maximum speed, if there was nothing more than first cost to consider; but there are other, and more important conditions to be taken into account. Principal among them is the required rate of movement when power is taken off, and the endurance of bearings.

In the case of line-shafting in manufactories, if the speed varied so much from the first movers on the machines as to require one or more intermediate or countershafts, the expense of fitting in this manner would be very greatly increased; on the contrary, if countershafts can be avoided, there is a great saving of belts, bearings, machinery and obstruction.

The practical limit of speed is in a great measure dependent upon the nature of the bearings, a subject that will be treated of in another place.

A FORMULA FOR THE BEST LENGTH OF CRANK PINS IN STEAM ENGINES.

By Theron Skeel, C.E.*

Any rotating journal being loaded has a tendency to become hot, the work absorbed by the friction of the bearing being changed into heat. If surrounded by a non-conducting material, all of this heat would be stored up within it, and the temperature would increase until the bearing was destroyed. The tendency to become hot decreases with the friction, and any means which reduce the friction also reduce the tendency to heat. These are the use of materials for the rubbing surfaces that slide easily upon each other, aided by a good lubricant.

It is claimed by some mechanics that so long as a film of oil remains between, it matters little of what material the rubbing surfaces are.†

There is, however, a limit of pressure, beyond which the lubricant is forced from between the surfaces. This limit is probably never reached in crank-pins, and is certainly above 2000 lbs. per square inch of bearing. The bearing upon a crank-pin is less than the projected area of the pin. As an example of the limit of pressure, a mill-stone 48″ in diameter, weighing, with its spindle and gear, 2600 lbs., can be run without excessive heating upon a point $1\frac{1}{4}$″ in diameter. The load per square inch of area of the point is 2600 lbs. nearly.

In computing the work of friction in a journal let—

P = load upon the journal in lbs.

d = diameter of the journal in inches.

l = length of the journal in inches.

N = number of revolutions per minute.

J = Joules' equivalent.

f = co-efficient of friction.

The work of friction in foot lbs. per minute:

$$W = P.f.\frac{\pi d}{12}\text{N}.$$

And the amount of heat stored up:

* Iron Age.

† A lecture delivered before the students of the Stevens Institute of Technology, by Coleman Sellers, Esq., 1872.

$$\frac{W}{J} = \frac{P}{J}. f. \frac{\pi d}{12} N.$$

It is probable that every unit of area of the bearing will dissipate an amount of heat depending upon its condition and independent of the whole area.

Let the number of units of heat dissipated by one square inch of surface on a crank-pin in good order $= q$.

Then, in order that the temperature of the pin may not increase, we have:

$$l.\ d.\ q. = \frac{W}{J} = \frac{P}{J}\ f. \frac{\pi d}{12} N.$$

Solving for l,

$$l = \frac{P}{J} \frac{f}{d.q} \frac{\pi d}{12} N = P.\ N. \frac{\pi f}{12.\ J.\ q.}$$

make $\frac{p f}{12.\ J.\ q} = \frac{1}{K}$

$$l = \frac{P.\ N.}{K}$$

The above formulæ were first published by Mr. Van Buren in "Strength of Iron Parts of Steam Machinery." He also pointed out that the tendency of the bearing to heat—with good lubrication—was independent of the diameter. From a number of cases in practice he deduced the value of

$$K = 350{,}000. \therefore l = \frac{P\ N.}{350{,}000}$$

where $P =$ area of piston $\times$ maximum pressure less back pressure.

It is the object of this paper to determine a simpler formula for the length of the pin. As the tendency to become hot depends upon the work done by the friction, it is proportional to the mean pressure upon the pin exerted during the stroke.

Call the area of the piston $= A$, mean effective pressure $= p'$.

$$\therefore W = p'\ A \frac{\pi d.}{12}\ N. f.$$

Let $s =$ stroke of piston in inch.

$$\therefore \frac{p'\ A. 2\ s.\ N.}{12 \times 33{,}000} = \text{indicated horse-power} = I.\ H.\ P.$$

$$\therefore p'\ A.\ N = \frac{I.\ H.\ P. \times 12 \times 33{,}000.}{2.\ s.}$$

substituting and reducing

$$W = \frac{I.\,H.\,P.}{2.\,s.} \times \frac{33{,}000 \times 12}{12}\,\pi\,d.\,f.$$

Now the amount of heat stored up is

$$\frac{W}{J}$$

and as before the amount dissipated is $l.\ d.\ q.$

$$\therefore\ W = l\,d\,q = \frac{l.\,H.\,P.}{2\,s} \times 33{,}000 \times \frac{\pi.\,d.\,f.}{J}$$

$$\therefore\ l = \frac{l.\ H.\ P.}{s.\ d.} \times \frac{\pi\ f}{q} \times \frac{33{,}000}{J}$$

$$\text{let } \frac{\pi\ f}{q} \times \frac{33{,}000}{J} = \frac{100}{K'}$$

$$\text{then } l = \frac{l.\ H.\ P.}{s} \times \frac{100}{K'}$$

$$\text{or } K' = 100 \times \frac{I.\ H.\ P.}{s.\ l}$$

This notation differs from that used by Mr. Van Buren in that the mean pressure is used in place of the maximum pressure, and the length of the bearing in place of the length of the pin. Most of the engines in his table carried the initial pressure in the cylinder about seven per cent. less than the boiler pressure. Also they cut off at about $\frac{3}{8}$ of the stroke. Therefore the mean pressure was about 9-10 the initial pressure. Also the length of the pin exceeded the length of the bearing about 10 per cent.

Therefore, K for this notation:

$$= 350{,}000. \times (0{\cdot}9 \times 1{\cdot}1) = 350{,}000, \text{ nearly.}$$

From Van Buren's formula:

$$l = \frac{P.'\,N}{32{,}000} = \frac{\text{mean pressure} \times N \times A}{350{,}000}$$

From the proposed formula,

$$l = \frac{\text{mean pressure} \times A \times N \times 2\,s \times 100}{33{,}000 \times K' \times S \times 12}$$

Place them equal to each other and there results:

$$K' = \frac{350{,}000 \times 100 \times 2}{33{,}000 \times 12} = 177$$

This formula is particularly applicable to compound engines, for which it is difficult to determine *a priori* the pressures in the cylinders, while the horse-power can be accurately estimated from the size and proportions of the boilers; or, in the case of a marine engine, from the figure of the ship and the proposed speed.

In this formula it must be borne in mind that l equals the length of the bearing on the pin, and not the length of the pin from face to face of cranks.

From the table of examples given below in practice there may be deduced the following: For a value of K'—more than 190—a stream of water has to be kept upon the pin. From 170 to 190 the pin will require close attention, perfect lubrication, and will be likely to heat with any neglect. From 150 to 170 ordinary care will suffice, while from 130 to 150 represents the best modern practice.

Therefore, the best value of l:

$$l = \frac{I.\ H.\ P.}{130 \times s} \text{ to } \frac{I.\ H.\ P.}{150 \times s}$$

Name of Vessel.	Line.	I H. P. (one Pin).	Length of Pin.	Length of Stroke.	Value of K'.	Remarks.
Madawasca	U. S. N.	3600	30	76	158	No trouble with pin.
Spain	National	1350	19½	54	128	" "
Colon	P. M. S. S. Co.	800	14	42	136	" "
California	Anchor	1250	15	42	199	Uses water constantly.
Adriatic	White Star	1750	16½	60	176	
Quang-See		600	14	42	102	
Ville du Havre,		1650	16½	54	185	Requires great care.
Celtic	White Star		16½	60		
Nevada	U. S. N.	2240	27	48	173	Worked cool.
Florida	U. S. N.	2000	27	48	155	" "
Adriatic	White Star	1500	16½	60	151	" "
Ormesby		320	8	36	111	Gives no trouble.
Manhattan	U. S. Treas.	194	6	26	124	" "
Egypt	National	1700	19½	54	162	" "

Chemistry, Physics, Technology, etc.

A NEW SYSTEM OF ENGRAVING PLATES FOR TYPOGRAPHIC PRESSES.

[A paper read before the Franklin Institute at the stated meeting, Nov., 1873, by J. Luther Ringwalt.]

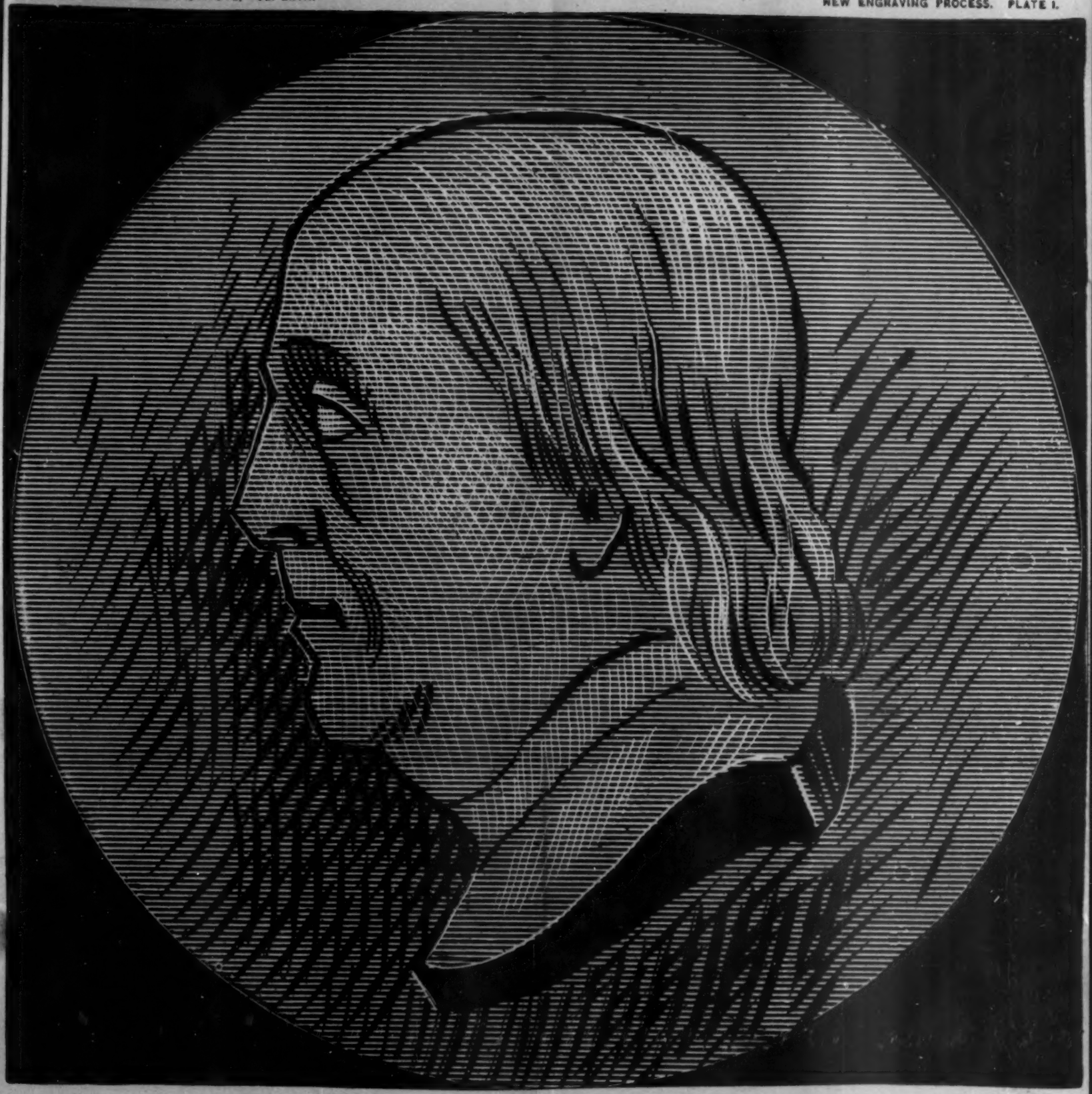
It has become a popular entertainment in some theatres and lyceum halls for artists to draw caricatures, scenes or portraits in the presence of an audience. I propose this evening to attempt the more difficult task of having drawn and engraved in your presence a plate from which impressions can be printed, and to explain the system by which such a feat is rendered possible. The preliminary preparations consist in the coating of a zinc plate with an acid-resisting varnish, and the subsequent scoring of the coated plate with parallel incisions, so that the effect of a series of straight alternate white and black lines is produced. The artist has also traced the outlines of the picture he intends to draw. [Simultaneous with the commencement of the reading of this paper Mr. Thomas Fleming began to draw upon the plate described, the lines necessary to convert it into a picture, and subsequently an engraving of a portrait of Dr. Franklin].

The art of engraving on wood is older than the art of printing with movable types, inasmuch as block books, cut on wood, preceded the products of Gutenburg and Fust; and it is a somewhat remarkable fact that, while wood engraving received an impetus from the invention of printing, which led to its rapid development to a very advanced stage, it gradually became, from a period near the commencement of the 17th century to a time near the close of the 18th century, so much neglected and abandoned that it fell almost wholly into disuse. The works requiring illustration during this period were embellished almost exclusively by the products of the copperplate press. In the latter portion of the 18th century, however, a revival of wood engraving began. The famous Bewick was the pioneer in this movement, and he restored the art to such a high state of perfection that he had numerous successors, whose labors became better and better appreciated, and evoked a larger and larger demand as the fact became apparent that, by a proper degree of care and skill, and the employment of good art assistance, pictures capable of being printed on the typographic press could be produced of so fine a grade that, for most

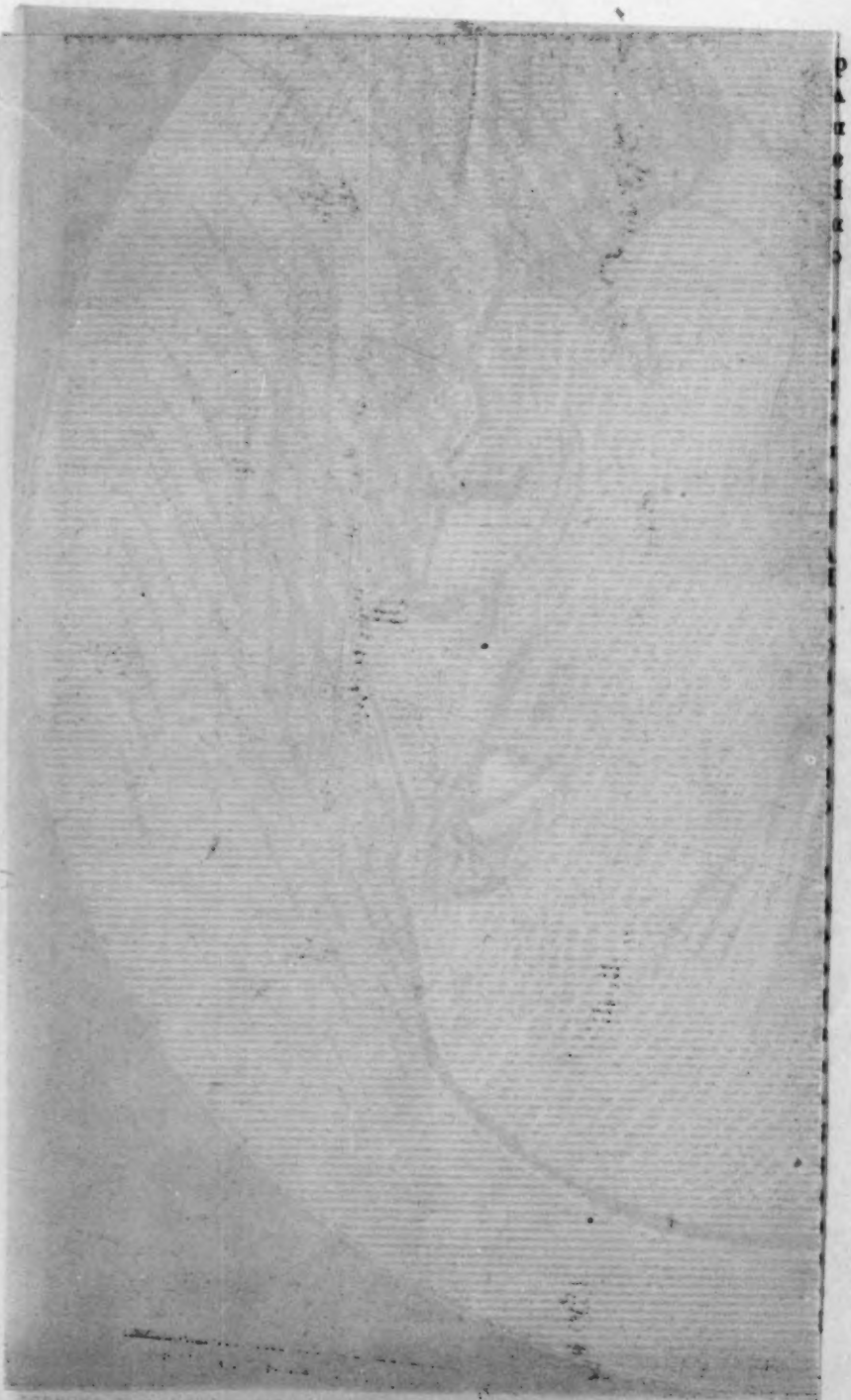
practical purposes, they would answer all the ends of copperplate engraving. Copper or steel plate pictures remain the most elegant and finished of any of the black products of printing; but they are subject, from an economical standpoint, to a great disadvantage, in the slowness and costliness of the methods by which they are printed; for, while the old hand printing press, capable of turning out only a few hundred impressions per hour, has been superseded by an immense variety of machines, some of which can print twenty thousand copies an hour, and while thousands of copies of excellent wood engravings are printed per hour on various wood-cut presses, the copperplate press is scarcely more rapid in its operation to-day than it was two centuries ago, and this conjunction of circumstances goes far to account for the rapid revival and extension of wood engraving during the last eighty or ninety years, and the relative decadence of copper or steel plate engraving for popular purposes.

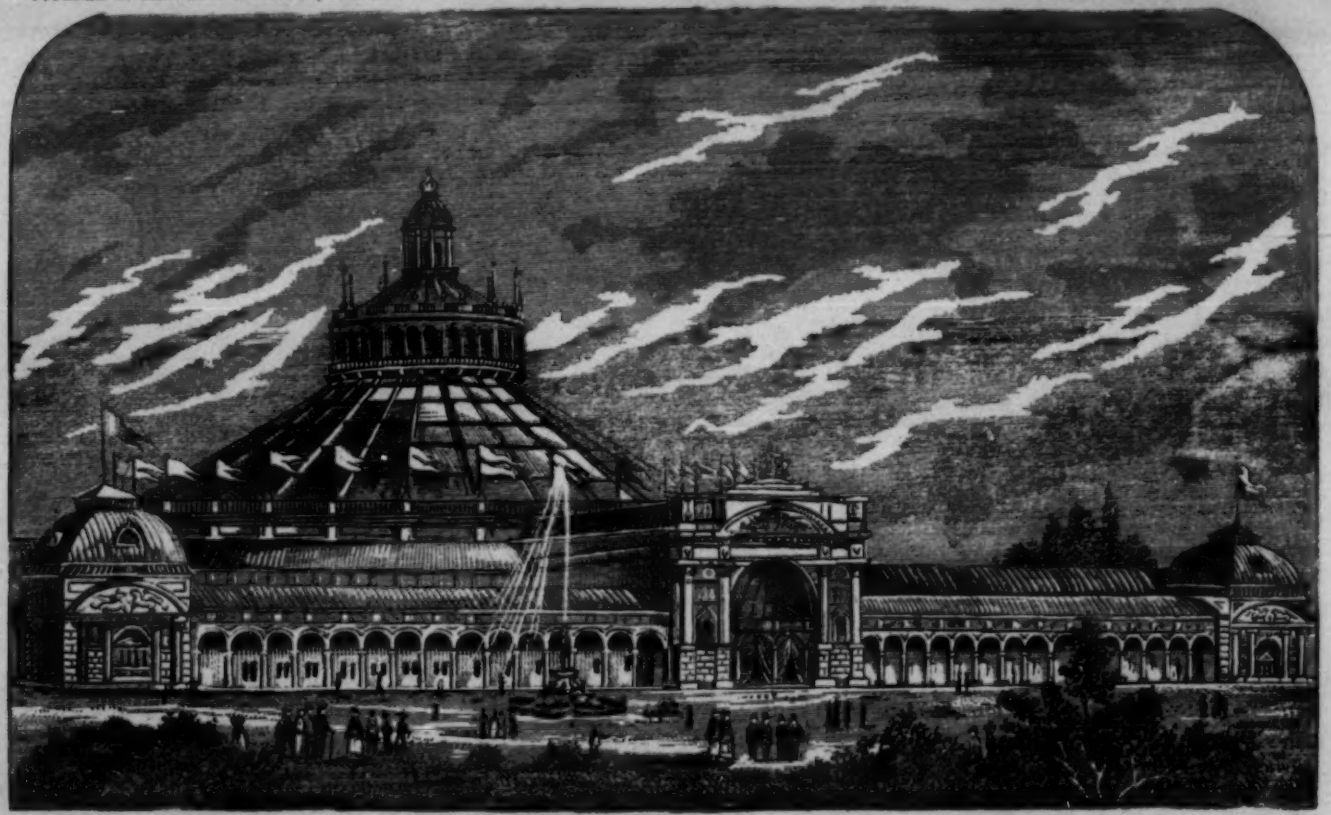
Desirable, however, as the products of wood engraving are, alike on account of their beauty and the rapidity and cheapness with which impressions can be taken, the art of producing them is tedious, difficult, intricate and expensive, and this fact has led to the employment of no inconsiderable amount of inventive genius in attempts to discover acceptable and economic substitutes. The motive which led to the discovery and extensive application of lithography was, if not identical with, at least akin to this incentive. The Daguerreotype and photograph had their birth in the same or a similar desire, and the Woodbury process is a still later outgrowth of the modern demand for illustration. Still, neither of these inventions exactly answered the precise object of supplying forms or plates from which pictorial representations could be multiplied with the readiness or rapidity attainable on either of dozens of typographical printing presses, and it is only during a recent period that the prospect seemed hopeful of finding substitutes for wood engraving that were in all respects entirely satisfactory.

One class of the experiments directed towards the accomplishment of this object has culminated in the discovery and application of a method for producing typographic printing plates by the aid of the photograph, and the action of light on gelatin and bichromate of potash. The products of this art, which are now becoming somewhat numerous, are good or nearly good enough for all practical purposes when the original is itself a printed picture, but the engravings produced by this method from drawings are frequently unsatisfactory



Impression from an Acid Engraving on Zinc, drawn and engraved in *Thirty Minutes* by RINGWALT PROCESS, in the Hall of the Franklin Institute, November 19th, 1873.





VIENNA EXPOSITION BUILDING.—*Acid Engraving on Zinc by Ringwalt Process, Patented July 1, 1873.*

unless a degree of finish, that can only be attained by long practice and great labor, has been employed in the preparation of such drawings.

Still another class of experiments, and the one to which I desire to call your special attention, is based on the employment of drawing implements, acids and tools, for the purpose of creating a raised surface on a metal plate that corresponds in its inequalities with the lines of a wood engraving. In France a great deal of attention has been paid to this system of operations during the last thirty or forty years, and M. Gillot, who died but a few months ago, brought the art of engraving with acids on zinc to such a state that it has been employed for many purposes, and resorted to with great frequency especially for illustrations of an inferior grade, which it was desirable to produce with great rapidity and cheapness.

M. Gillot demonstrated that, if a drawing is made on a piece of polished or grained zinc with a pigment or substance sufficiently powerful to protect the lines drawn from the action of acid, the whites of a picture may be eaten away, by acids, to a sufficient depth to afford the relief necessary for a typographic engraving, the acid thus doing the work of the graver; and, this principle of production being established, the details to be perfected relate to the substances to be used in drawing, the methods of applying them, and the selection and management of acids during the process of engraving.

A somewhat detailed description of the Gillot process will be found in an article published in the "Printer's Circular," of this city, for October, which I contributed to that journal, and it is therefore unnecessary to describe it more fully here.

One of the characteristics of the engravings produced by the Gillot process, which it seemed to me desirable to avoid, was their want of resemblance to wood engravings. Although printed on typographic presses, many of the specimens I have seen looked more like inferior lithographs than wood engravings. This peculiarity I believe I have fully succeeded in avoiding. [Specimens were here distributed among the audience of printed products, of various kinds, shapes and sizes, from very small pictures to posters, and some of the plates from which they were printed were also exhibited.] You may consider the pictures good, bad or indifferent, but very few persons would suppose they were produced by any other process than wood engraving; and the pictures themselves can be made as good as the art work employed in their preparation.

One of the most embarrassing difficulties involved in all attempts to produce acceptable substitutes for wood engraving arises from the great variety in the depths of the different portions of the plate or block from which impressions are to be made. It is easy enough to make all the black lines necessary to produce a printed picture; but one of the most serious tasks is to get rid of all the superfluous wood or metal that must be removed before the parts intended to be white can escape the searching touch of printer's ink. The slightest scratch on a space surrounded by the black parts of a picture will create a white mark, while indentations of considerable depth are required for all whites of considerable breadth—the general rule being that each enlargement of the area of the white portion of a picture requires a corresponding increase in the depth of the block or plate from which inpressions are taken. Wood engravings are made up of a series of black and white lines, and the essential requisite in their production is the arrangement of these lines in appropriate artistic harmony, and with due regard to the effect requisite for the proper representation of the object to be illustrated. In many wood engravings the principal portion of the picture consists of a series of white and black lines or surfaces, which do not at any point possess any considerable depth or occupy any considerable area of the plate; and it occurred to me that many pictures, good enough for practical purposes, could readily be produced by creating, mechanically, on a plate a series of straight black and white lines, as the basis or substratum on which any desired design could be drawn.

This idea I have practically applied to the production of a considerable number of engravings, intended for various purposes, and impressions from these engravings have been taken on all the leading varieties of typographic presses. I have also patented this principle or process of production, as will be seen from the following extracts from the specifications of a patent granted to me by the United States Patent Office in July last, viz.:

The object of my invention is to produce quickly and at a cheap rate plates from which pictures may be made by an ordinary typographic printing press, and this object I attain by drawing on a varnished and scored plate, with acid-resisting varnish, the picture to be produced, and then subjecting the plate to the action of appropriate acid.

In carrying out my invention, the first thing to be done is to select a metal plate of proper size, having a perfectly plane and smooth surface. I prefer, both on the score of economy and efficiency, ordinary sheet zinc. I first cover the plate with a thin coat of varnish, or other material capable of

resisting the corrosive action of the acid to which it has to be subsequently subjected. I then, by means of a ruling machine, score the entire surface of the plate. * * The varnished surface of the plate may be scored with any system of lines which the character of the picture to be produced may suggest, the scoring determining the style of groundwork of the picture. After the varnished plate has been thus scored it is ready for the artist, who proceeds to paint with a resistant varnish on the scored surface the design or figure he desires to produce. * * At the points where high lights are required the varnish is scraped away and the metal surface of the plate exposed to an extent and form determined by the character of the lights. The plate is now subjected to the action of dilute nitric or sulphuric acid, or other corroding bath usually employed in etching, the acid eating away all the parts of the metal exposed. When this process has been completed, the varnish is removed from the face of the plate, and the latter is then mounted on a block of appropriate thickness, and this block may be used for printing from in an ordinary typographical press, the ink adhering to those parts only of the plate which had been covered with the varnish. The impression taken from the plate will consequently be precisely like the varnished portion of the same. * * More elaborate plates way be produced by varying the character of the scoring in a manner which the nature of the picture to be produced may suggest.

The operation now in progress is based on these ideas. [Reference was here made to the drawing which Mr. Fleming was about completing, and a few minutes later he immersed it in an acid bath.] A zinc plate is covered with a varnish capable of resisting the action of acid. Through this varnish a series of lines are drawn at regular intervals, thus opening up avenues in which the acid can make the desired incisions; and the shape, thickness, position and direction of these lines or scorings can be varied so readily that the basis of pictures of any desired grade of fineness can easily be established. If the plate was subjected to the action of acid immediately after the completion of this operation, impressions from it would present a mere alternation of straight white and black lines, of a width corresponding to the width of the incisions and the length of the time the plate was exposed to the action of acid of a given strength, or to the strength of the acid applied: for it is worthy of remark that a great variety of shadings and effects can be produced from a given ruling by the variation of the strength of the acids applied, or the variation of the time during which the plate is subjected to the action of acid of a given strength.

After a plate has been covered with a protecting varnish, and scored in an appropriate manner, the artist in his drawing creates additional blacks by applying a protecting liquid with a pen or brush at the points where additional blacks are required, and removes with an etch-

point or scraper the original protecting ground from the places where additional whites are necessary. This operation finished, the plate is next subjected to the action of dilute acid, and during this process a variety of beautiful effects can be produced by stopping out or covering with a protecting varnish different portions of the picture at various stages.

This resource supplies a very fair substitute for the varied shadings of an India ink drawing.

By these simple methods I conceive it to be possible to represent almost any desired object; while, by a resort to the analogous process of Gillotage proper, a variety of broad and deep whites can be obtained, when they are necessary; or, if Gillotage fails, mechanical processes can be employed for the removal of the metal from places where broad and deep white areas are required.

All young arts necessarily encounter many minor difficulties and obstacles, which can only be fully surmounted by devices discovered or suggested during a protracted experience. They do not suddenly spring into existence, fully equipped at all points; but, when they are based on correct principles and calculated to supply a popular demand, they gradually attain a perfect development.

That acid engraving on zinc, for the production of typographic plates, will reach this point, I firmly believe; and the extensive application of such an art, not merely at a few great commercial centres, but in hundreds or even thousands of printing offices scattered throughout the world, would lead to the illustration of thousands of objects of business or literary importance, from machines, houses, animals, furniture, the varied manufactures described in business catalogues, and men, to events and localities, of which no adequate description is now given; and thus the movements and things of the age would be faithfully portrayed for present instruction and the enlightenment of all coming generations.

[At the conclusion of the reading of this paper, which occupied about thirty minutes, the drawing and engraving of the plate referred to was completed, and in a few minutes later a rough proof, beaten off with a planer, was handed round among the audience. A more finished impression of the same plate accompanies this article.]

DESCRIPTIVE GEOMETRY MODELS.

By S. Edward Warren, Mass. Inst. of Technology.

Being not very unfrequently consulted by letter relative to the varieties of models used in illustrating Descriptive Geometry, and the way to procure them, I have thought that a few notes on the subject might be interesting to many of the readers of this Journal.

Descriptive geometry models may be classified superficially according to the materials of which they are composed; or, more rationally, according to the kind and amount of aid and study which they are capable of affording.

According to the first basis, such models may be described as wood, tin and wire models; plaster models; and string models.

According to the second basis, models may be designed, *first*, merely to give an idea of forms unfamiliar in common life, with such of their elementary properties as are obvious on a little reflection by inspection of those forms; for example, any popular audience would understand what was meant by a pyramid, a cylinder, a cone, or a sphere; but at the mention of a hyperboloid, conoid or helicoid, there would probably be a nearly unanimous look of wonder, and a felt demand for a model: *second*, models may be designed to add to this an exhibition of the *results* of certain combinations of forms, as the intersection of two cylinders; and, *third*, they may illustrate the means of obtaining these results, point by point, and either, 1*st*, *in space*, or, 2*d*, *in projection*, or, 3*d*, *in both*.

From this general view of the subject, we may now proceed to a more particular account.

I know of no models which illustrate, both in space and in projection, the *operations of the solutions* of problems; such, for example, as finding the intersection of a line and a plane, or of two solids, and others of analogous character; except a few, made partly by myself, and partly by workmen under my direction, for my former classes at the Rensselear Polytechnic Institute, at Troy, and which, so far as made at the ex pense of that institution, are presumed to be there still.

The nearest approach to this essential completeness in any models manufactured for sale, so far as I know, is in the Schröeder models, made at Darmstadt, in Germany. These show lines by stout brass wires; planes of tin, painted white; and solids, of pear wood, dowelled with brass pins when necessary, in case of combinations of solids.

Here it may be said in passing, that the brass pins by which models are often dowelled together, are usually too short or slender, so that the model tumbles apart at a touch in arranging it. By making them of one eighth to one quarter inch wire, or rod, tightly fitted, this difficulty is obviated, and the model is more readily put together. The Schröeder models further show the projections of forms on wooden planes of projection in their real positions at right angles to each other, and covered with varnished paper, on which the projections are engraved. But they do not show the auxiliary lines and planes in space, which are employed in finding the required results, such as lines of intersection, of bodies combined in given ways; and in this respect they fail, like all other models, at the very point where learners most need help. Still, they are very useful, and by far the most serviceable that I know of, in that they leave less to be imagined than any others do.

Illustrated price lists of Schröeder's models, illustrative of every art, can be had through any of the German, or other importing booksellers.

Plaster Models, designed by Bardin, in Paris, simply show intersecting pairs of bodies; showing clearly the finished result in space, of their penetration, and so far showing the reality, which is found in projection by graphical construction, and thence imagined in space with more or less difficulty. But they exhibit neither the reality, nor the projections, of the means for obtaining these results; so that the lecturer is strongly tempted to draw pencil lines upon them, to assist in concieving of the methods of finding their curves of intersection. Such models are made in Paris by Muret, and by Les Freres, Rue Oudinot, and lists would doubtless be found at French and German book importers.

String Models are of two kinds. The first are fixed string models, each of which simply shows some one example of some unfamiliar surface, generally a warped surface. The second are the celebrated Olivier models, in which the strings are kept stretched by little weights attached to each, and concealed in boxes on which the model stands, and through the top of which the strings pass. This curious construction is because the models are transformable, so as to show various forms of the same surface, by shifting the perforated brass bars or rings to which the strings are fastened. The depth of the boxes which conceal the weights is nicely adjusted to the extreme range of motion of the weights, occasioned by shifting the supports of the strings.

The late Prof. Gillespie informed me some years ago, that there were then but three sets of these models in existence, of which his own, then and probably now at Union College, Schenectady, was the fullest and most complete.

These models are too costly for most institutions, and too complex except for advanced students, who might spend days upon each or many of them in unravelling all that the model could teach. But a few fixed string models of warped surfaces, and of intersecting cylinders or cones are very useful, and can easily be made by any one, with a little aid from an instrument maker, or a cabinet maker, in in making the wood or metal supports of the strings.

Indeed, it is by no means the highest mechanical finish that makes a model most useful; and when mechanical laboratories become as common as chemical ones, as they ought to be, and when *thoroughness* shall replace *haste* among the national deities, nothing could be more admirable than to spend a school year on Descriptive Geometry (other work duly included), and require each student, as a part of his work in the mechanical laboratory to make and present a card-board model of every problem which he should draw. But this result touches another question, viz: that of expending five years in doing the work which is now crowded into the existing American four-year courses of scientific instruction; and by means of a general course of three years, preparatory to a purely professional one of two years; the two being under one management, or in allied institutions.

Nearly connected with models, and yet not quite entitled to the name, are pictures of models, or picture models, that is, isometric, or oblique projections of real models. These, by representing in dotted lines important parts, which the *opaque materials of real models often conceal*, are often better than the models themselves.

No model, for instance, could show *more* clearly than such figures do, the point of intersection of a line with a plane, and how to find it; or the conditions under which two cylinders, etc., will intersect in one curve, or in two separate curves; together with the turning points of the curve and its relations thereat to the elements of the given surfaces.

To conclude with a suggestion: it would be doing excellent service to technical education, to establish in this country the manufacture of models possessing the completeness of design which I have indicated as not yet attained; and accompanied by charts of corresponding pictorial views of the same.

SANITARY CARE AND UTILIZATION OF REFUSE OF CITIES.

(A paper read before the American Public Health Association, Nov. 12, 1873.)

By Jacob J. Storer.

That the conclusions I have arrived at respecting the proper treatment of animal refuse may be better comprehended, it is necessary that a brief description be given of the most advanced methods now practiced.

From most of the packing and slaughtering houses the blood from the slaughtered animals flows into receiving tanks, whence it is gradually removed to different places to be manipulated for its albumen, or dried for a fertilizer, or some other purpose. In summer the heat causes the blood in these receiving tanks to become offensive in a few hours. Hence the first cause of complaint.

I would reccommend that such tanks be made double, the inner one of iron and the outer of wood, ane that a space of from six to eight inchesbe left between the two, which shall be kept filled with ice or shall have cold water constantly flowing through it. This should keep the blood at a temperature at which decomposition and consequent offense would be prevented.

In some cities the blood and much of the offal flows directly into the sewers. Where there is a plentiful supply of water and the sewer mouths are far enough off, or emptying into a rapid current, there may be but little objection to this plan as far as the city adopting it is concerned, but towns and neighborhoods along the course of the river, below the sewer mouths, as shown by statistics throughout Europe and this country, suffer to a great degree. To allow this, then, cannot be a good sanitary measure.

The great need of the times is that an economical system be devised, and everywhere adopted and carried into effect, by which the tank steam, blood and tank offal, &c. of packing, slaughtering and rendering houses shall be disposed of without violating the laws of health.

Boiling and Fat-Melting Establishments.—The steam and gases from the tanks in which solid animal matter is boiled or steamed, for the purpose of extracting the grease, are perhaps the greatest causes of the offense appertaining to these establishments.

The usual method of conducting the steam and gases through cold iron coils for partial condensation, and making the uncondensed portion pass up through the fires under the boilers, is in most cases ineffectual, for the reason that the boiler fires are rarely, if ever, of

sufficient capacity or intensity to decompose and burn all the steam and gases, while that portion of them passing undecomposed or unburned through the coils has its temperature immediately reduced by contact with the heat-absorbing surface of the boiler and escapes with its bad odor into the air.

Where this method is in use the exceedingly offensive condensed steam is generally permitted to flow into the sewers or water-courses, to the detriment of health.

Conducting the steam and gases through heated tubes and then into a good fire is complete and effectual, provided their volume is not in excess of the effective power of the apparatus.

Another plan recently brought into notice is to pass the steam and gases through cold coils, allowing the condensed portion to run into the sewers, while the uncondensed portion is passed through vessels containing lime, for the removal of some of the stench, and thence over naptha, benzine or gasoline, for the absorption of carbon, and then is burned as illuminating gas or carried under the boilers to generate steam.

A portion of the offensive odor in this case is transferred into and concentrated (not destroyed) by the lime, while the rest is rendered inoffensive by burning.

As the uncondensed steam and gases can be properly disposed of without the intervention of lime or liquid hydro-carbons, it is not easy to discover any advantage in their use.

By another method, recently introduced, the steam and gases are blown off into a closed tank, and there condensed to a good degree by copious sprays of water holding in solution sulphate of iron and chloride of lime.

The uncondensed portion, still offensive, is conducted under the boiler fires. The condensed portion is inoffensive, and no objection can be made to its flow into the sewers.

The filtering of the condensed steam through charcoal or other substances for the purpose of deodorizing it, while the uncondensed is burned, is another method.

There are several other devices, approaching, as these do, the solution of the problem; but it will be seen that no matter what condensation or purification takes place, a large portion still remain uncondensed and offensive and has to be disposed of.

The Most Effectual Scheme.—The plan I find most effectual and economical is to build a combustion chamber or oven with a deep ash-

pit, made water-tight with cement. The roof of this chamber is full of small openings made by leaving 2″ or 3″ spaces between the ends of the bricks. An oven or chamber four feet square, with a roof four or five feet above the grate, will suffice for any packing house, if the tanks are blown off successively—no two at the same time, no matter how large the escape pipe.

The steam and gases are then blown off through a cold coil; the condensed steam runs into the ash-pit basin, where it is gradually evaporated and, passing up, is burned by the fire above; the uncondensed steam passes directly up through the fires.

A slight blast keeps the oven always at a white heat, the roof detains the gases and steam until they are thoroughly decomposed and burned, and at the same time serves to concentrate the heat in the oven.

The escaping flame may be utilized for generating steam, heating furnaces or any other economical purpose. The apparatus is simple and the result is perfect, no offensive odor escaping.

The Disposal of Offal.—The next point for consideration is the care of the tank offal.

A beeve gives 50 lbs., a hog 20 lbs., and a sheep 7 lbs. of this.

In some instances this is thrown into the water-courses, in some upon the surface of the ground, or buried in trenches to be gotten rid of. It is even permitted by the health authorities in some places to accumulate during the winter, when it gives but little or no offense, and be gradually worked up into a fertilizer during that season, while the excess is allowed to remain in decomposing and stinking heaps throughout the next summer until the return of cold weather, when the fertilizer manufacturer gets again at work.

Public health demands that this offal shall not accumulate any where, and that the disposal shall be inoffensive, thorough and immediate. The same demand is made respecting the dead animals of the cities, and those dying in transit on their way to them.

Public economy—the agricultural interests—requires the utilization of this material.

My attention was first called to this subject about a year ago, and though it was entirely outside of my legitimate business I became interested enough to investigate the matter in all its details of defects and needs, and have made extensive and practical experiments and observations for the purpose of discovering a proper system of manipulation.

The importance of the results obtained must be my apology for alluding to the method I have designed and practised.

Of the treatment of the tank steam and gases I have already spoken.

I found that the various offal driers in use were slow in action and offensive in operation. That it was most desirable for sanitary reasons that the blood and offal should be dried and rendered inoffensive immediately on their production; that no accumulation of them should be permitted, and that, consequently, for places where much packing is done and for all large cities, driers should be designed and operated of much greater capacity than any then in use.

One Scheme carried out in Chicago.—I designed and erected at the Union Stock Yards, adjoining Chicago, a brick-lined cylinder 20 feet long and three feet internal diameter, having at one end a fireplace and at the other a smoke-stack.

The intense flame of burning pulverized fuel is injected directly into the cylinder, which has a capacity to treat four tons an hour of mixed blood and tank offal. The jet of flame is not only intense but is constant, so that the drying of the material in the cylinder is very rapid.

In the base of the smoke-stack is a gas combustion chamber of the style and dimensions spoken of in the first part of this paper, and a hot fire is constantly maintained therein.

The offensive steam and gases escaping from the cylinder when in operation, pass into this combustion chamber, and are there decomposed and burned so completely that no offensive odors escape; while the resulting flame often extends 20 feet up the stack, bringing its firebrick lining to a white heat. This flame is sufficient to generate all the steam required to run the machinery of the works. That its results were most satisfactory may be judged from the fact that the Trustees of the town of Lake, wherein the works are erected, closed all the other offal-drying establishments within their jurisdiction early in the summer, because of the offense they created, but urged that my works should be kept in operation. At the close of the past summer they unanimously passed a series of resolutions thanking me for having conducted the works without creating any offense whatever, and declaring that for years they had not had a season so free from nuisances, and requesting me to increase the capacity of the works in order that the town might be further freed from foul odors and the accumulation of animal refuse.

Dr. Miller, the Sanitary Superintendent, and Dr. Reid, the Health Officer of Chicago, have often visited my works and fully endorse the expressed opinions of the town of Lake authorities.

Encouraged by this action of the authorities, I have arranged to have in operation there in a few weeks another cylinder capable of drying 10 tons of raw blood and tank offal an hour. The machine is 50 feet long by 5 feet in diameter.

A jet of pulverized fuel, constantly burning in the gas combustion chamber in the base of the stack, will insure thorough decomposition and burning of all the offensive gases and steam which must so rapidly escape during the treatment of this large amount of material.

From various causes, lack of co-operation, etc., I have not been able to carry my system into practice in all its details.

Still Another Plan.—A further step in this system is the treatment of the tank water or soup.

It is estimated that there are about twelve gallons of tank water, or soup, made per beeve, three gallons per hog, and one gallon per sheep; according to these estimates, there is annually produced in Chicago, and permitted to run into the water courses and sewers, about 8,000,000 gallons. or 36,000 tons.

It is easy with these figures to arrive at the amount produced in other cities.

This 36,000 tons of tank-water carries with it to the river not less than 4,000 tons of animal matter in solution, or suspension, after the heaviest particles of matter have been deposited in catch basins.

Some obtained near Boston, and filtered through a charcoal filter, still retained in solution eight per cent. of animal matter in the form of glue. This is exceptional; as a general thing, I think, the animal matter is of such a character as to be easily removed by proper filtration. Many persons have attempted to solve the problem how to separate the animal matter from the liquid, so that only clear water should flow into the sewers.

It appears to me the best plan in most cases would be to run the liquid, as is now usually done, into catch basins, where the heavier particles of the solid matter will settle, thence into a second series of basins, where still another considerable portion shall be precipitated by chemicals. The soup, now partially cleared, carrying say from five to eight per cent. of solid matter in solution, should be made to flow from the precipitating basins and be submitted to the downward

intermittent filtration process, through earth, which has been so successfully adopted for the treatment of the sewage in some towns in England.

I think the adoption of this plan would insure the flow of clear water into the sewers.

In the choice of precipitants to be used in the second series of tanks or basins we should be guided, I think, not only by a desire to obtain an effective precipitate, but also by the cost of the material and the value of the resultant. I suggest that milk of lime be first thoroughly stirred in with the liquid, and that then sulphuric acid be added.

This treatment causes a quicker and more complete precipitation than any I have tried, the resultant contains nothing not of value as a fertilizer, while the cost of the chemicals is fully recovered in the value of the material.

This process is not adapted to the treatment of tank-water containing a considerable amount of animal matter in the form of glue. A proper treatment in such case has, I am assured by Mr. B. F. Shaw of Cambridge, Mass., just been discovered by him and is about being applied at the works of the Boynton Packing Company. He claims to remove all the glue in solution, leaving the water odorless and almost colorless, and that the result of the animal matter removed more than covers the cost of the manipulation.

Pork Packing and Slaughtering Houses.—There is still another point of importance that has received but little attention and which yet is a matter of serious offense from hog packing and slaughtering houses.

From three-fourths of a pound to a pound of blood, bristles and dirt is deposited in the scalding vat by each hog scalded. Invariably, I believe, this water with its burden of animal matter is permitted to flow into the sewers. In the presence of so many and great causes of offense this one has been generally overlooked, yet it requires consideration.

Mr. Shaw designed and has in operation, at the establishment of the Packing Company above spoken of, a successful method of treating this matter which I will briefly describe:—

The water for scalding is generally kept at a temperature of about 145° Fahrenheit. When it has become foul and offensive from use he mixes with it some charcoal dust and allows it to cool down to about 90° Fahrenheit. This is done between the hours of slaughtering. To

hasten the cooling, ice may be used. When the water is cooled sufficiently a quantity of blood, and sometimes a small amount of sulphuric acid, is thoroughly stirred into it, and, after the mass is well mixed, the temperature is raised to the boiling point for a few minutes.

The coagulum caused by this means encloses the charcoal and the impurities that were suspended in the water, when they are removed by a skimmer of netted wire.

The water is thus made pure and sweet enough for use again, and may be cleaned and used several times successively.

Mr. Shaw suggests that the scrapings and wash water of these establishments may be collected in vats supplied with steam-heating pipe, and manipulated in the same manner.

It is possible in this way to prevent wholly the escape of blood, manure and scrapings from the drains of slaughtering establishments. The material recovered from these scalding vats is valuable as a fertilizer, and more than reimburses the cost of the operation.

In most instances the packing, slaughtering and rendering establishments are *scattered* throughout our cities, each one offending a very considerable neighborhood, jeopardizing its health and depreciating the value of the land and houses thereabouts.

Few of the establishments can afford to erect works for drying their offal and blood, or adopt proper means for the care of the tank water, &c. Those who can afford to do so, do not care to add to their other business that of manufacturing fertilizers.

A Good Suggestion.—The removal of these establishments to one location would result in very great pecuniary as well as sanitary advantages to the neighborhood from which they move; while their assemblage at one place would make it easy for them to adopt a system of management that would satisfy all sanitary conditions. At this place, wherever it might be, one establishment could be erected which should treat all the blood, offal and tank water each hour of its production. The blood and offal could be hauled to the drying works in covered carts, all offense being prevented by dusting the interior of the carts with powdered charcoal, and covering the tops of their contents with the same, while the tank water could be conducted by sewers into one common reservoir for treatment.

Glue and Bone Works.—Prominent among the nuisances to be found at glue works, is that arising from the heaps of skulls, bones, hoofs and horns, generally piled in the open air till the flesh is re-

moved from them by gradual decomposition. From these arise constantly the most offensive odors. I know from practice a simple and effectual remedy for this nuisance.

Enclose a common house furnace in a brick chamber, the cover or top of this chamber to be made of iron gratings, or perforated plates; on this is built a strong wooden bin with a roof, in which shall be an opening, say two feet in diameter. A fan blower is placed near the top of the bin, having both a suction and force pipe. This bin is filled with these skulls, etc., and fire made in the furnace, the suction pipe attached to the opening in the top of the bin, and the fan put in motion. The heated air is drawn up through the contents of the bin, and with its burden of moisture and offensive gases, is ejected through the force pipe into the fire. A few hours of this treatment is more effectual than weeks by the present offensive method. The *expense* of establishing new methods has been the principal cause of hesitation on the part of health departments, in enforcing practical improvements.

Considering that the element of time enters largely into all practical values, I have endeavored to show the economy of a rapid and thorough system of manipulation of the animal refuse of cities.

GRAMME'S MAGNETO-ELECTRIC MACHINE FOR CONTINUOUS CURRENTS.

Translated from the French by Alfred Niandet-Breguet.

The induction currents present themselves more frequently with the double character of being instantaneous and of being alternately of opposite character. Many are of the opinion that these induction currents cannot be produced without these two conditions. This is a great error, for it may be said that none of the phenomena in nature are instantaneous in the proper sense of the word, and in each particular case it could be shown that the time of these induction currents may be estimated. If we consider, for instance, the machine of Pixii (called Clarke), we see that the production of the current in each bobbin lasts as long as the motion of this bobbin between the north and the south pole of the magnet, and the duration of this motion may vary considerably and become very great. If the machine is made to move slowly, the current continues sensible to the galvanometer. As to the possibility of obtaining continuous induction currents, that is to say of an indefinite duration, it has been shown

by Faraday himself, in his first essay on induction, of November, 1831, that they are producible. He caused a plate of copper to revolve around its centre, the edges of which passed between the two poles of a magnet, and by means of a galvanometer he perceived the passage of a current from the centre of the plate to the point between the two poles and the magnet.

Thus, said Faraday, (page 27, Vol. 1, "Experimental Researches,") was demonstrated the production of a permanent current of electricity by ordinary magnets. This beautiful experiment figures in all the English elementary works. Unfortunately it is very little known in France, at least under this form, from which has resulted the error which we have pointed out in the beginning, and which is so prevalent in France.

It is important to notice, beside, that if this fine experiment of Faraday's has not received practical application, it is for the reason that the production of electricity by this process is not susceptible of multiplication.

The problem of the production of the electricity of induction in

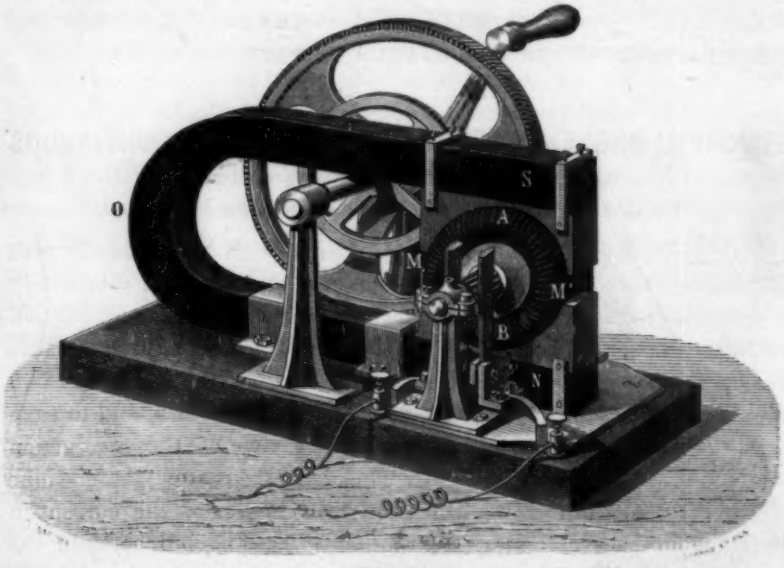


Fig. 1.

abundance may therefore be reasonably aasumed. It appears that Sir Charles Wheatstone had found the solution of this problem, and that he had neglected to publish it because he found it not very prac-

tical. Things were in this state when Mr. Gramme made known in July, 1871, to the Academy of Sciences, a machine that completely solved the problem, for which he took out a patent in 1869.

Gramme's machine (Fig. 1), is composed of a magnet, between the poles of which revolves an electro-magnet of a new form that requires a minute description. This electro-magnet is formed of a ring of soft iron, over which is wound a conducting wire, presenting no break in continuity, so that we may consider it formed by an ordinary electro-magnet curved into a circle; the two ends of the wire being so soldered to each other to establish continuity. This piece may

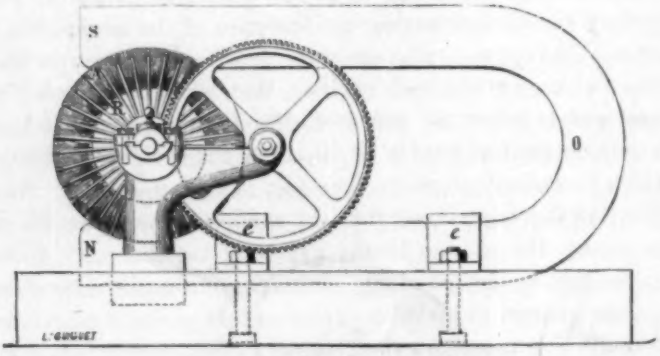


Fig. 2.

be considered as an endless electro-magnet, since the soft iron and the conducting wire are absolutely continuous. It constitutes the first part of the invention of Mr. Gramme. In Fig. 3, the electro-magnet is represented in section at A, and in the other figures it is seen with the wire with which it is covered; it is movable around its centre on an axis, to which movement is given by means of a pinion and a cog-wheel M, or other device (Fig. 1 and 2). Let us now see how the current is produced in the wire of the endless magnet. This wire we have said is without break of continuity, but it is arranged in sections, each composed of about a hundred revolutions. The end of the last revolution of one of the elements in question, is the commence-

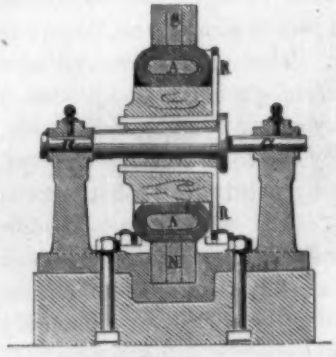


Fig. 3.

ment of the first revolution of the following element; altogether the wire is therefore divided in forty sections, all equal and forming a continuous pole. We must examine experimentally the production of the current in one of the sections or elements, and for this purpose we attach its two ends to two wires connected with the galvanometer. We start from the line (which we call the line of distribution) perpendicularly to the line of the poles, and we give to the considered element a series of movements of 10° each, at the end of each of which we give time to the needle of the galvanometer to retake its positon of rest.

We see that during all this time the said element remains above the plane of distribution, the direction of the motion remaining the same. The currents that are there produced in it are in the same direction, which we will call positive, that when afterwards the said elements passes below the plane of this distribution. The currents which are then produced are in the direction which we will call negative, and which is contrary to that of the first half of the circle. We may also prove in this experiment that the change in the direction of the motion causes the change in the nature of the current. From that instant, we can, by the knowledge procured from one of these elements, come to the general phenomena produced by the whole machine. All the elements that are above the plane of distribution are the points of the currents, which are at all times of positive sense. They can be unequalled between themselves but for the same velocity of movement their sum is evidently always the same, for, as one of these elements passes above or below the plane of distribution, it is replaced by another. Again, the elements above the plane of distribution are the points of the negative currents; the sum is constant and equal to that of the currents of the superior part. Thus the machine, reduced to the parts that we have already described, presents two systems of elements producing unequal and contrary currents, or, in other words, two opposed currents; that is to say, they are neutralized. This system can be better understood if formed by two Daniell's batteries of 20 cells each, put in opposition by poles of the same name. We now come to the method employed for collecting these currents, which method is similar to the one we have already used. To collect the currents of the two batteries in opposition it suffices, as we already know, to put the two ends of the circuit in contact with the points of reunion of similar poles. The batteries having been placed in opposition, the currents which before were neutralized, and the circuit closed,

we will have our currents in any quantity. We will here show that this is the same as Gramme's method, and that this manipulation constitutes the second part of his invention. The different sections of the endless electro-magnet are connected by radiating metallic plates R, made of copper, (Fig. 2 and 3), which, being placed close together, are yet properly insulated. The finishing end of one section and commencing end of another are connected to one of the metallic radiating plates R, which must consequently be of the same number as the sections. It is seen that R has a radiating form (Fig. 2 and 3), but it is, for convenience, bent near the centre, at right angles, and being insulated one from the other, they appear like a concentric circle to the ring, and on the opposite face. Two rubbers not shown, presenting the form of discs of brass, bear against the circle formed by the extremities of the pieces R, at two points that are exactly in the plane of distribution, that is to say, at the place where the equal currents of opposite natures produced in the two-halves of the ring oppose one another. Consequently the two currents commence to proceed together along the exterior circuit that is made to bear on the rubbers. The absolute continuity of the current obtained in this way results from the rubbers rubbing at the same time on many of the pieces R, the result of which is that the metallic circuit is never broken. The effects obtained by the means of these machines are changeable by the speed which we give the ring of the electro-magnet.

The electro-motive force is as much greater as the number of coils of wire wound around the ring, but the relation between these two quantities has not yet been determined. It will afford a subject of interesting investigations. The theoretical resistance of the machine ought to be the fourth part of the total resistance of the wire wound around the ring ; but little attention is needed to account for this. But the real resistance is smaller because each rubber bears always on many junction pieces, R, of the elements, and that the resistance of the elements thus pressed by the rubbers is diminished by the resistance of the circuit. For obtaining electric force more and more intense, machines of Gramme may be put together as elements of batteries are put together, whether for tension or for quantity. As to the possibility of obtaining greater effects by augmenting the dimensions of the machine, it is too evident to stop and consider. By means of this machine we may perform all the experiments that are made with batteries, chemical decompositions, heating of fine wires, putting in action

electro-dynamic apparatus or electro-magnets, electric lights, etc. Hence there is reason to expect that it will be applied in a short time outside of the physical laboratories, properly speaking: 1st, in medicine, to furnish continuous and discontinuous currents. 2d, in electric telegraphing. 3d, in galvanizing, for gilding with silver and gold. 4th, in electric lighting. 5th, in the military art for the explosions of mines. 6th, in chemical decompositions, etc.

General Advantages.—We have now to examine the interest that presents itself in the application of the machine, and to find in a general manner what advantages it presents over the battery. Before all, we must note the absolute constancy of the currents furnished by the machine as long as the speed does not change; this constancy has been preserved for eight hours in an experiment made with one of the first machines that were constructed, maintained at a uniform motion by a Fontane motor. During this duration, the deviation of the needle of a galvanometer was strictly invariable. That understood, persons who have handled the Daniel battery, (which is by far the more constant of all batteries) know that if the electromotive force did not vary, so to speak, its resistance varies constantly, so much that in two experiments made in the interval of a minute, we would not have exactly the same intensity. A battery is a very complicated machine, for each one of its elements is composed of four solid and distinct parts, viz: outside vessel, porous cup, electrode positive, electrode negative, and of two liquids, and in the greater number of applications we are obliged to employ a sufficiently large number of elements. The results of this multiplicity of parts that compose a battery, that it is subject to many derangements, the simplest of which, the breaking of one of the glass vessels, is sufficient to stop entirely the production of the current. To the complication of the battery it is interesting to oppose the simplicity of Gramme's machine, which requires hardly any care. It is very remarkable that batteries are, with very few exceptions, horses at livery, that is to say that they cost as much at rest as when they are used. Gramme's machine, on the contrary, costs nothing when it does not furnish any current. This may be understood in two ways. It is at first evident that we may stop the rotation of the machine when we do not need a current, but it is very remarkable that, even in the case when it turns, it does not waste any mechanical force if it does not furnish a current in an exterior circuit, (allowance being made for the force destroyed by the friction of two trunions and of bearing springs). There is need

to stop for a moment at the second point in order to establish it in an incontestible manner. If one considers Gramme's machine in rapid motion, and furnishing in an exterior circuit on the condition always that the exterior resistance may be equal or greater than the interior resistance, we prove that it does not become warm. From which we may conclude that all the mechanical force transmitted to the machine is converted in electricity, for no portion of it is converted into heat. If the machine, continuing to turn with the same velocity, has its exterior circuit broken, it is still shown that the machine does not become heated, which shows that in this case there is production of neither heat nor electricity, and consequently that there is no waste of mechanical force, and we may even notice that the production of the currents is such in this machine, that when there is no exterior circuit to set them flowing they compensate and balance one another so exactly, that they do not circulate in any way, since they do not heat their own circuit. If Gramme's machine is put in motion by a force just sufficient to make it turn at a determined velocity, when it furnishes an exterior current, and if we break the circuit off all at once, we see the machine immediately take an increasing velocity, the mechanical force which is transmitted to it not being able any longer to transform itself into electricity, is transformed in mechanical force by augmenting the velocity of the movable pieces of the apparatus. Reciprocally, if Gramme's machine is maintained in a sufficiently rapid motion while the circuit is open at the moment in which we close the circuit, we see the velocity of rotation diminish; that is to say, that a portion of the mechanical force of the machine, and of the fly wheel that may be attached to it, is converted into electricity. In these reciprocal experiments we pass from a first to a second state of equilibrium between the expenditure of mechanical force and the production of electricity. In conclusion, we may say that Gramme's machine is an apparatus very nearly perfect, for the transformation of mechanical force into electricity, or in other terms, that this machine does not expend any more than it produces. With these remarkable advantages of the Gramme machine, it is important to note the saving of time in preparing electrical experiments for the laboratory. The getting up of a Bunsen battery is an operation not only very expensive but very long. This we must hesitate in getting up, if we have not before us several hours of labor. On the contrary, the Gramme machine is always ready, and permits the repeating of an experiment that was left in series of experiments

from one minute to another, or to make a grand demonstration of a known phenomena. From this point of view it would be interesting to construct the machine equal to 10 or 12 Bunsen elements, by means of which we could repeat the greater part of the new experiments in the instruction of physics.

Experiments in electro-dynamics, electro-magnetism, electro-chemistry, etc., the various studies made with the induction coil, called Ruhmkorff, can be facilitated by means of Gramme's machine, which dispenses with acids and the cleaning of batteries.

We again call attention to the general accessory advantages of this machine over the battery; the acid vapors and the inconvenience resulting therefrom, the danger of manipulation and of poisonous substances, by careless assistants, the injury which may often accompany the manipulation of liquids, and the trouble of keeping up constant batteries, are altogether avoided. An objection can be put forth that this machine always requires an assistant to put it into motion, and that this motion cannot be indefinitely continued. This difficulty is not as great as it appears to be; that is to say, we can very often turn the machine and use it at the same time. It can be turned by hand or by foot, in the same manner as the sewing machine, which latter leaves the two hands free. If, then, one has need to put off the experiment for a long time, or to be at liberty altogether, he can employ any motor whatever.

This will be for the industries an ordinary steam engine; for the laboratory, or the telegraphic bureau, a domestic motor.

ON THE MANUFACTURE OF TIN PLATE.

A paper read before the Franklin Institute of Philadelphia, on the evening of October 15th, by Thomas S. Speakman, Esq., representative of the Institute at the Vienna Exposition, gives the following interesting details of the manufacture of tin-plate as carried on in Wales:

In the opinion of Mr. Henry I. Madge, tin-plate manufacturer, of Swansea, in Wales, from whom I received the following information, the manufacturer prefers making his own iron to purchasing it, because he can thereby insure a more regularly equable quality; he therefore buys suitable pig-iron.

For common coke tin-plates, the "iron bars" are made from puddled iron. The puddled ball is sometimes squeezed and sometimes

hammered; much depends on the care of the puddler to so bring forward his ball that all its parts shall be equally decarbonized, when the fracture will be of a uniform dull gray color, without crude admixtures of bright crystals. The unreduced crystals produce more or less wasters of the iron plates, and if any such escape the notice of the mill manager, the wasters are thrown aside again, after being expensively covered with tin. If they escape the eye of the "assorter," the tin-plate worker will find them to fracture across the angles or bends of the sheets in working them up. The puddled ball produced under the best conditions is then taken to the "shingler," who submits it to the squeezer or hammer, sometimes both. This operation should be carefully executed. As the puddled ball is rugged and full of cinder, the cinder has to be well squeezed out by this operation, and at the same time the roughness must be so managed as to be welded into a solid compact mass, which cannot be so well done in after operations. Some say it cannot be done afterwards, as the whole mass can never again be brought up to a thorough welding heat throughout, unless at the expense of much waste and loss. The bloom from the "shingler" is at once passed through the rolls, or roughed down into No. 1 bar; some prefer letting the blooms lie exposed to the action of the elements for a time, and others think it of no importance. The bar while hot is cut into lengths and piled, five pieces being put and heated together in the "balling" furnace, or repeating. When the faces are brought up to a welding heat, and the whole mass softened, it is again taken to the hammer (some rolling at once), others returning the bloom into the furnace, to bring up the heat again. It is then rolled out into the finished bar, of suitable size and thickness for the kind of plates required.

Some manufacturers have made very good iron from the puddled ball direct, and saving in wasters and improving the quality, but as the labor and number of hands were reduced by this mode, the men struck against it, and spoiled their work if not well looked after. This kind of iron was homogeneous, and not fibrous, as the iron "piled" and brought through the reheating furnace. The "shingler" must be very careful to form a second bloom under the hammer, and the bloom should be upset once or twice, so as to secure a welding of all the rough edges. If, after the shingling, the bloom has lost too much heat, it should be reheated. Care and expedition will remedy that necessity, and the reheating furnace may be dispensed with alto-

gether. The saving is much in cost and waste; the trouble with the workmen great. Some also produced very excellent iron from the puddling furnace by adding to the charge about 60 pounds of scrap or shearings, the trimmings of the plates when cut to size. The 60 pounds of shearings were thrown into a bath of saturated solution of nitrate of soda, and added to the charge during the "boiling." The advantages gained were—the scrap iron improved the charge in the proportion it bore to the whole mass; it was melted down quickly without waste, as the smelting took place under the surface. The weight of solid cold iron would take it to the bottom of the charge, carbon would be eliminated by fusion with the nitrate, and thereby improve the quality of the charge again. The ball was treated in the same way as ordinary puddled balls afterwards. The iron was tough as charcoal iron, but the characteristics of puddled iron arising from crudities for crystals unreduced were not exterminated but greatly reduced. A careful puddler can at all times prevent these crude lumps to a very great extent. Another saving arising out of the process was that the scrap "shearing" formerly put into a furnace and reduced to a welding state, hammered out and rolled, gave only a return of 13 cents to the ton, whereas the other returned the full weight of the shearings. Difficulties with the union men prevented them from pursuing this mode of manufacture.

The Tin Mills.—The bars are cut up into the required sizes, brought to a cherry-red heat in a reverberatory furnace, rolled out to a certain length by gauge, "doubled" and returned to the furnace rerolled, again doubled, heated and reheated. The several foldings of the sheets adhere slightly.

After the sheets are cut down to size for tinning they are separated from each other by what is called opening; during the process of opening, "stickers" and imperfect plates are thrown out, and the passed sheets then go into the "pickling room." There they are put into a hot pickle of dilute sulphuric acid, to be cleansed from oxidized and silicious matters, and undergo another rough examination in the "scouring process;" that is, any plate not cleansed is rubbed with sand in water. Defective sheets are again thrown out, and the sheets or plates are now passed into the annealing room.

The annealing furnace is a large reverberating furnace capable of holding several annealing pots. The pot is composed of a stand of sufficient size to take the sheets, with a raised rim. Several hundred sheets are piled on the stand, and a square, box-shaped cast pot com-

pletes the pot. This is inverted over the sheets, and the space between the rim of the stand and the rim of the inverted pot is filled with oxide of iron, to lute it down and exclude the air. The pots are then put into the furnace until it is full and the whole brought up to a cherry-red heat, or a little beyond. About eight hours are necessary for its perfect saturation by the heat. When removed from the furnace they are slowly cooled in a place free from draft and then the pots are opened. The plates never lie perfectly flat, and should be of a dark straw color at the edges. If the air should get in in small quantities, a deep blue color will cover the sheets more or less. The plates adhere slightly, are again separated, and ready for the second pickling room. The plates are then submitted to a hot but more dilute pickle of sulphuric acid, and again chemically cleansed; taken from the acid bath they are well washed in running water, and kept in clean water until the tinman is ready for them.

The Tin House.—The tinman takes the plates from the water-bath (where they lie some hours) and plunges them wet into a bath of hot palm oil called the "grease pot." When they have acquired the temperature of the grease pot they are removed with tongs and quickly submerged in a bath of tin. The oil mixed with the water from the plates floats at the top, forming a flux to cover the melted tin and prevent oxidation. With the tongs, the sheets or plates are continually kept moving and separated, to insure the tin getting between all of the sheets. When the bath has recovered its heat, which it generally does in about half an hour, the tinman examines the charge, and finding that perfect amalgamation has taken place between the two metals, he removes them, in quantities convenient, with a tongs, to the next bath, which is kept at a low temperature.

The temperature raised by the change from the "tinpot" is again allowed to cool down to a few degrees over the melting point of the tin, when the plates are taken in lots of a dozen or two at a time, and laid on an iron slab which is at the side, or head of the pot. The waste metal and grease run back into the pot, the slab being inclined. The workman then takes up sheet by sheet in the tongs, and dips each into another bath of fine metal kept at a heat a little over melting point, immediately withdraws it, and places it in a rack immersed in a large pot of melted palm oil kept at the proper temperature, where they are allowed to remain a certain time. The sheets are then slowly lifted out of the grease by a boy, who separates them

into proper lots by counting carefully, regulating the intervals of time between them. The grease recoils from the top plate, and as little is left on the sheets they are again placed in a rack in the open air to cool; when cool a lad takes each sheet in a tongs, and dips the lower edge into a small bath of melted tin, so regulated that the sheet can only enter to about the eighth of an inch. It is kept long enough to melt off the drops of metal which adhered to the lower edge, and when lifted the sheet is struck to throw off the superfluous metal from the edge. The plates are again put into a rack, and taken while warm to a bin of bran, where each sheet is thrust into and under the bran, to get rid of the grease which adheres. It is then passed on to a second and third hand, when the grease is pretty well left behind in the last bin, which is kept filled with new bran. The sheets are turned out covered with flour dust and bran, and dusted off with cotton shaggy cloth. The next process is in the sorting room.

The finished sheets are laid on tables, and each sheet undergoes an examination by the sorter, who throws out those shearings which are defective in the iron or trimmings. The latter are reheated to regain the tin; the imperfect sheets are sold as "wasters" at a less price; the sheets are counted, and the box of 100 weight is composed of 225 sheets of 14x10 for home use or for exportation.

ON SOME RECENT IMPROVEMENTS IN THE MANUACTURE OF ARTIFICIAL STONE, AND THE APPLICATION OF SUCH STONE TO CONSTRUCTION AND OTHER PURPOSES.

By Frederick Ransome, Esq. (of England).

After the reading of the paper by Mr. Ransome, at the Massachusetts Institute of Technology, at Boston, U. S. A., on the evening of Thursday, November 13th, 1873, the following observations were made during the discussion which ensued thereon:

Dr. T. Sterry Hunt, LL.D., Professor of Geology, expressed his satisfaction at the beautiful results arrived at by Mr. Ransome, who, after years of experiment, had solved satisfactorily and completely a great industrial problem. He had followed with the more interest the labors of Mr. Ransome during many years, from the fact that he himself had formerly carried on, in 1857–58, a series of experiments very similar in character and in chemical results, in his endeavors to find out the method by which certain soft earthy rocks, consisting in

great part of silica and carbonate of lime, have become hard and crystalline. The speaker had shown, by researches in the laboratory and also by observations of limestone strata in the vicinity of eruptive rocks, that a reaction between silica and carbonate of lime takes place in the presence of carbonate of soda, by which the alkali brought about, little by little, the solution of the silica, and its union with the lime to form a hard silicate of lime. This is nature's method. The action of alkali in dissolving the silica and then again giving it up to the lime, was an example of many of the so-called actions by presence, which are really cases of ordinary chemical affinity acting under peculiar conditions. It was reserved for Mr. Ransome, by using both the lime and the silica in their free, soluble and active forms, and by bringing in the alkali already combined with a portion of silica, to make this curious reaction very rapid, and to show that the product forms a cementing material which is available for binding particles of sand into hard, stone-like masses. Mr. Ransome has also shown that the small amount of alkali used in the process itself, unites with the successive portions of silicate of lime formed, and becomes locked up in an insoluble compound, as in the case with alkali in granite rocks. Hence the new artificial stone, unlike the earlier products obtained by Mr. Ransome and by others, contains no soluble salts to be got rid of.

In reply to a question as to the fitness of artificial stones like this to resist the effects of fire, Dr. Hunt compared its constitution with that of granite, in which an important element is a vitreous crystalline quartz. This cracks like glass when exposed to sudden changes of temperature, and thus produces a sudden exfoliation or crumbling of the granite, as was well seen in the great fire of Boston, in 1872. On the other hand, sandstones of really homogeneous character, which consist of small grains of quartz bound together by a cement, are among the substances best fitted to resist these changes of temperature. He alluded to his observations of materials like the Potsdam sandstone of Northern New York and Canada when exposed to conflagrations, and said that the material made by Mr. Ransome's process is an artificial sandstone, and would, he conceived, be eminently fitted to resist the effects of fire.

John M. Ordway, Esq., A.M., Professor of Metallurgy and Industrial Chemistry at the above College, said: Some fifty years ago Fuchs discovered that peculiar adhesive compound of alkali and silica called "water-glass," and it has ever since been a problem how to render this solution of sand available for the manufacture of artificial

stone. Fuchs himself made mixtures of the potash and soda silicates with sand and other inert substances, and thus produced solid masses having great tenacity, but the cementing material still remained soluble in water. Others have tried water-glass for hardening soft and porous natural stones, as well as for making a concrete of coarse powders, but without important results.

Mr. Ransome appears to have been the first to remove the alkali or render it insoluble after moulding the mixed materials into any desired form, and he has thus rendered silicate of soda practically useful in the production of a firm stone capable of resisting all atmospheric agencies. His first mode was to submit the moulded mass to a heat sufficient to cause the silicate to combine with the surfaces of the sand particles, and thus make an insoluble vitreous cement throughout the entire mass. The results were satisfactory, but in carrying out the process many practical difficulties were met with, and these were mostly overcome by very ingenious devices on the part of the inventor. Still the drying and burning required care, labor and fuel, and it was felt to be highly desirable to produce an equally strong stone altogether in the wet way. This end was at length reached by the use of chloride of calcium as a fixing agent.

Thus was developed the second plan, which soon proved to be an improvement of the highest importance, for it rendered possible the use of the stone for a much greater variety of applications.

To allow the chloride of calcium to soak in, and the resulting chloride of sodium to soak out, a certain degree of porosity was essential, and therefore very fine materials could not be used. Moreover, it was obviously difficult to effect a complete conversion of the soda silicate into a lime silicate in the interior of a thick mass of the moulded mixture. So a further improvement was desirable; and finally Mr. Ransome succeeded in using such materials for cement as would of themselves become insoluble and require no after treatment with chemicals. Thus a stone can be produced of any desired thickness and solid throughout.

This is effected by adding to the ingredients hydraulic lime and active silica, the active silica being in time transferred through the agency of the alkali to the unsaturated base of the hydraulic lime—while the soda also itself unites with the silicate of lime to form an insoluble double silicate of lime and soda. Thus, the persevering inventor appears now to have reached the highest degree of perfection of which a water-glass cemented stone is capable.

It has been maintained, and the view is coming to be generally accepted, that the hardening of hydraulic and Portland cements is in a great measure owing to the transferring power of a small portion of alkali which such cements are generally found to contain. Mr. Ransome's last process there is an intensifying of the reactions which take place in the solidification of ordinary hydraulic cement, while the product is made very much richer in combined silica, the substances which afford the greatest resistance to atmospheric and abrading agencies. The hardening is accelerated by the use of water-glass, and, instead of ageing for days or weeks, a very resistant stone may be made in a few hours. Hence this process is of especial advantage for engineering work demanding rapidity of operation.

It may be of interest to mention that some of the bricklayers of Boston have been for years accustomed to take advantage of one principle involved in Mr. Ransome's last process, and by so doing, to make the poorer qualities of hydraulic cement equal to the best. It often happens in plastering a continuous surface, as a cellar floor, that owing to some defect in the material the coating remains a week or more without setting. In such cases, if a dilute solution of water-glass is sprinkled or brushed on, the cement becomes firm and resistant in one hour or two.

Franklin Institute.

Proceedings of the Stated Meeting held October 15, 1873.

The meeting was called to order at the usual hour, with the President, Mr. Coleman Sellers, in the chair.

The minutes of the previous meeting were read and approved.

The Actuary submitted the minutes of the Board of Managers, and reported that at their stated meeting, held October 8th, donations to the Library had been reported as follows:

Journal of the Statistical Society of London, for June, 1873. From the Society.

Journal of the Chemical Society of London, for May, June and July, 1873. From the Society.

Journal of the Society of Arts of London, for July, 1873. From the Society.

Proceedings of the Royal Society, Nos. 138—145 (1873). From the Society.

Monthly Report of the Chief Engineer of the Manchester Steam Users' Association, for May, June and July, 1873. From the Association.

Proceedings of the American Philosophical Society, Philadelphia, January to May, 1873. From the Society.

Proceedings of the Royal Institution of Great Britain, vol. vi, parts 5 and 6. From the Institution.

Mittheilungen der Geographischen Gesellschaft in Wien, for 1872 From the Society.

Report on a Topographical Survey of the Adirondack Wilderness of New York. From Verplanck Colvin, Esq.

The Journal of Applied Sciences, January to May, 1873, London. From the Editor.

The American Ephemeris and Nautical Almanac, for 1876. From Prof. J. H. C. Coffin, U. S. N.

Contributions to our knowledge of the Meteorology of the Antarctic Regions. From the Meteorological Society, London, 1873.

Results of a Series of Meteorological Observations made under Instructions from the Regents of the University at sundry stations in the State of New York. From the Regents of the University of New York.

The 83d, 84th and 85th Reports of the Regents of the University of New York, 1870, 1871, 1872. From the Regents of the University.

The Fifty-fifth Annual Report of the Trustees of the New York State Library, 1873. From the Regents of the University.

Civil List and Forms of Government of the Colony and State of New York: Albany, 1869. From the same.

Manual for the Use of the Legislature of the State of New York, 1871. From the same.

The Actuary likewise reported the minutes of the several standing committees.

The Committee on the Mode of Determining the Horse Power of Steam Boilers presented two reports which embodied their views. It was, thereupon, on motion, resolved, that while not adopting the views of either report, the Institute accepts the same; and further that both reports be published in the Journal for the information of members. Mr. Edward Brown, the Chairman of the Committee, then gave a brief history of the work of the Committee, and concluded by urging

its discharge. It was, thereupon, on motion, resolved, that the Committee be discharged, and that the thanks of the Institute be presented to the gentlemen composing it, for the faithful manner in which they had performed their laborious task. The reports in question will be found published in the Journal for December, 1873.

The President next announced a paper, by Mr. William M. Henderson, upon "An Improved Hydraulic Railroad Car Brake." The paper, together with the discussion which it elicited, will be found published in the Journal for December, 1873.

The Secretary then presented his monthly report on Novelties in Science and the Mechanic Arts.

The Committee on Conflagrations reported progress, and was continued.

Under the head of new business, the President announced the receipt of a communication, signed by sixteen members of the Institute, requesting that the Reading Room and Library of the Society be opened on Sundays between the hours of 10 A. M. and 3 P. M. The subject elicited considerable expression of opinion, favorable and unfavorable, participated in by Messrs. LeVan, Orr and Close. A motion to defer action upon the subject until the November meeting finally prevailed.

The Secretary then announced the presence at the meeting of Messrs. David Brooks, Thos. S. Speakman and J. E. Mitchell, the representatives of the Institute at the Universal Exposition at Vienna. The President thereupon signified to the gentleman named the desire of the meeting to receive any communication which they might be prepared to make.

Mr. Brooks, in response, remarked that his attention had been devoted mainly to the subject of electrical science and its application to the telegraph and other practical uses. "There was not so much that was especially new or novel in electrical matters at the Vienna Exposition, as there was of improved constructions indicating scientific progress. The articles and processes there exhibited were mainly in the direction of perfecting what was hitherto well known.

"Amongst the novelties were the Gramme machine, the magnets of M. Jamin, and one of Siemen's, of Berlin. The performance of the Gramme machine was shown by the melting of wires, the production of brilliant luminous effects and rapid chemical effects. A magnet of Jamin's, weighing one hundred pounds, was there exhibited, which supported a weight of five hundred pounds in addition to its own armature, weighing twenty five pounds.

"An immense magnet, by Siemen's, of Berlin, was also displayed, which, weighing several tons, and rotated by steam power, produced magneto-electric force